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TECHNICAL MEMORANDUM
RAC-T-462(FOE)

NOVEMBER 1965

RESEARCH ANALYSIS CORPORATION

Study of the Prepositioning Concept: Operation BIG LIFT Final Report (U)

by
Ralph A. Hafner
Carl F. Blozan

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1. Transmitted herewith for information is (are) _______copy (copies) of RAC-T-462 (FOE), subject as above.

2. RAC-T-462 (FOE) was prepared by the Field Office, Europe of the Research Analysis Corporation, McLean, Virginia, under contract DA-44-188-ARO-1.

3. The function of the Field Office, Europe, is to provide study support for the Seventh US Army. This report was prepared as part of the Field Office Europe Research Project 3, "Review and Evaluation of the Concept and Procedures Pertaining to Prepositioned Equipment in Seventh Army." A companion paper, RAC-TP-140 (FOE), "Study of the Prepositioning Concept Prior to BIG LIFT," was published in April 1965.

4. It is to be noted that RAC-T-462 (FOE) presents the views of the Research Analysis Corporation and that it is not an official publication of the Department of the Army.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

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RAC FIELD OFFICE, EUROPE
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McLEAN, VIRGINIA

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RAC-T-462 (FOE)

ERRATA

P 3, para 2, l 1. *Change to read:*
"Prepositioning the equipment of only the divisions with a very minimum combat and combat service support makes the deployed divisions almost completely dependent on Seventh Army for support."

P 5, para 10. *Change to read:*
"Prepositioned equipment be standardized with that current in the theater; however, this equipment must be compatible with the state of training of the CONUS units being deployed."

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FOREWORD

The principal function of the Research Analysis Corporation Field Office, Europe (RACFOE) is to conduct studies of problems considered by the Commanding General, Seventh Army, to be most pertinent to increasing combat readiness of the command.

This report was prepared as a part of RACFOE Research Project 3, "Review and Evaluation of the Concept and Procedures Pertaining to Prepositioned Equipment in Seventh Army (U)." The objective of this project is to study current organizational structure, procedures, and practices necessary to maintain equipment in a combat-ready posture, with a view toward possible improvement within the resources of United States Army, Europe.

This report is concerned with prepositioning during and after Operation BIG LIFT. A companion paper, "Study of the Prepositioning Concept prior to BIG LIFT (U)," was published as RAC-TP-140(FOE) in April 1965. Following BIG LIFT an interim report was prepared and distributed within Seventh Army for comment. These comments were used in preparing this final report, in which findings of the entire prepositioning study are summarized. Changes in the application of the prepositioning concept are constantly being made. Changes made after July 1964 are not reflected in this paper; however, the conclusions and recommendations of this study are still applicable.

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Director, RAC Field Office, Europe
Headquarters, Seventh Army
APO 46, New York

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ABSTRACT

This is the final report of a RACFOE study concerned with the prepositioning of equipment in Seventh Army. It covers Operation BIG LIFT—the period from 8 Jul 63 to 31 May 64. A previous paper, "Study of the Prepositioning Concept Prior to BIG LIFT (U),"[1] covers the period from inception to 31 Jul 63.

The prescribed maintenance procedure prior to BIG LIFT was proved inadequate because of the amount of preparatory inspection and repair required. Consequently, a new procedure was initiated on 31 Jul 63. The demand on theater manpower resources was such that it could not be met in an emergency, and it was suggested that the prepositioning of the equipment of selected slice elements would solve this problem. An assumption that a "period of tension" existed was necessary to the success of the operation.

The prepositioned equipment of the 2d Armd Div was studied through all phases—from preparation for issue, through the field training exercise, to preparation for restorage. The restorage phase for prepositioned vehicles is still not completed. Equipment of the "aggressor force," the 3d Armd Div, was studied during similar periods to establish a control for comparison purposes. Comparisons are made in all phases.

With the exception of some standard B equipment (M59, armored personnel carrier, M48 tank, and the M38 $\frac{1}{4}$-ton truck), the performance of the prepositioned vehicles was comparable with those of the 3d Armd Div. Failures reported for nonautomotive equipment were negligible.

The airlift and marrying-up phases were also examined, and it is concluded that after the start of hostilities the operation is most vulnerable in the staging areas, unless these are dispersed.

After the exercise the replacement of many vehicles by the more modern models current in the theater began and the conversion of the prepositioned unit equipment to Reorganization Objective Army Divisions was resumed. The custodial group was reorganized along more functional lines on 1 Apr 64, with some restationing of personnel and materiel. The maintenance procedure used in preparing for BIG LIFT was used as a model for the revised procedure.

Maintaining the equipment in ready-for-issue (RFI) condition appears to offer a better payoff than postponing necessary repairs until the period of tension becomes a reality.

SUMMARY

Problem

To evaluate the concept of prepositioning equipment from data accumulated during Operation BIG LIFT.

Facts

The equipment of an armored division and of an infantry division is prepositioned near the rear boundary of the Seventh Army for issue to these divisions when they are deployed to the theater. The main purpose of this prepositioning is to achieve rapid response.

In Operation BIG LIFT the 2d Armd Div, with several support elements, was airlifted from continental United States (CONUS) to Europe; picked up its prepositioned equipment; engaged in a field training exercise (FTX), in which the 3d Armd Div acted as the main aggressor force; returned the equipment to storage; and was airlifted back to home station.

The prepositioned equipment used was in the custody of the Armored Maintenance Group (AMG). Additional equipment required for the Reorganization Objective Army Divisions (ROAD) configuration was obtained from other prepositioned stocks and theater units. The AMG became part of the consolidated Augmentation Readiness Group (ARG) on 1 Apr 64.

Discussion

One of the purposes of Operation BIG LIFT was to test the feasibility of (a) airlifting a division from CONUS to Europe, (b) marrying it with its prepositioned equipment, and (c) deploying it rapidly as an effective fighting force. Important factors in the examination of this concept include the vulnerability of the division during the operation, the effort required to maintain the prepositioned equipment before and after issue, and operational readiness and reliability of the equipment.

Information on these factors was acquired by a RACFOE team augmented by 20 officers and 40 enlisted men from Seventh Army units. Emphasis was placed on observing the performance of the prepositioned vehicles. For a sample of approximately 25 percent of the 2d Armd Div vehicles, the data on the following were acquired: (a) effort expended in preparing the vehicles for

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issue; (b) mileages driven and failures experienced; and (c) repairs reported. In order to provide a standard against which to measure 2d Armd Div vehicle performance, similar data were acquired for a sample of 3d Armd Div vehicles performing the same functions. Ordnance reports supplemented these data.

For convenience the operation is reported in three phases:

(a) The preparatory phase (8 Jul–24 Oct 63) included vehicle preparation, the airlift, and the staging process. The 478 mechanics and drivers organic to the AMG were augmented by 604, and together they expended 471,000 man-hours (m-hr) of quarterly (Q) inspections and road tests. On the basis of man-hours available, preparatory maintenance averaged approximately 143 m-hr/2d Armd Div vehicle, including overhead.

During the airlift operation, nine truck companies shuttled incoming troops to the staging areas rapidly enough so that the maximum troop concentration at an air base was only 6 planeloads. At the staging areas, however, the concentration of troops and equipment became critically high for about 24 hr. During this period one nuclear weapon could have destroyed almost half a division. Increased dispersion of the equipment appears necessary if the airlift is to be made after hostilities commence.

(b) The maneuver phase (25 Oct–12 Nov 63) included the march to the assembly area, the FTX, and the return march. Operational readiness of 2d Armd Div vehicles at the start of the march is estimated to have been greater than 98 percent. During the march, vehicles in both divisions moved slightly more than an average of 100 miles, with the 2d Armd Div experiencing a vehicle-deficiency rate of 10 percent and a dropout rate of 3 percent. In the 3d Armd Div the deficiency rate was 7 percent and the dropout rate was 2 percent.

During the FTX, 2d Armd Div vehicles moved on the average about 25 percent further than 3d Armd Div vehicles—a distance of approximately 600 miles for wheeled vehicles and 300 miles for tracked in 2d Armd Div. Near the end of the FTX, in both divisions, part of the corrective maintenance was deferred until return to home station.

(c) The restorage phase (12 Nov 63–Jul 64) was not completed at the time data collection was terminated. Vehicles prepared for storage have been sampled and the results extrapolated to the division. The introduction of new equipment to replace older vehicles may change the expected replacement volume; however, the substitution is proceeding too slowly to acquire data for this study. The large number of replacements required in the restorage period points to the possibility that the amount of preparatory maintenance, though it was extensive, was limited by the allowable preparation time.

AR 220-10[2] estimates that it would take 90 days for normal support to be established. To establish a measure of reliability the percentage of vehicles expected to require no major assembly replacement during a specified period of operation (usage rate taken to be 1000 miles/month for wheeled vehicles and 500 miles/month for tracked vehicles) was calculated on the basis of BIG LIFT data. This percentage, called the "Period Reliability" (computed, in this

illustration, for a 90-day period), is shown in the accompanying tabulation for 2d Armd Div vehicles, and comparative percentages are given for 3d Armd Div vehicles.

Vehicles	Division	
	2d Armd	3d Armd
Armored personnel carrier (APC)	40	55
Tanks and self-propelled (SP) howitzer	48	48
All wheeled	49	59
All tracked	44	52
All vehicles	48	57

CONCLUSIONS

1. The concept of prepositioning materiel to expedite reinforcement of the existing defense force is unquestionably valid. Anything less than full implementation of the concept rapidly compromises its potential and austerity may even make implementation infeasible in view of its impact on the defense force.

2. Prepositioning the equipment of only the divisions makes the deployed divisions almost completely dependent on Seventh Army for support. This demand can be reduced by prepositioning the equipment of selected support units of the division slices and the appropriate level of supply, including parts. The authorized stockage list (ASL) or authorized organizational stockage list (AOSL) of the divisions must remain intact if the divisions are to be autonomous for the designated period. A study of this aspect by the Technical Services is strongly indicated, including a schedule for phasing-in of the personnel of these slice elements and organizational support elements, and augmentation of the ARG for the increased workload.

3. The value of early warning cannot be overemphasized. The earlier the alert, the greater the probability of success of the deployment.

4. With adequate transportation support and proper scheduling, troop concentrations at air bases were acceptably low. At the peacetime staging areas the concentration became so critically high that one well-placed nuclear weapon could have destroyed half the division. Planned dispersion of the equipment at the time of the warning to preselected areas of about company size would minimize the vulnerability of the divisions. This implies a general state of readiness of the equipment. Movement plans should be cognizant of this movement. The custodial group may require assistance for the rapid dispersal of the equipment.

5. The maintenance procedure in effect prior to BIG LIFT was ineffective. The current procedure, modeled after that followed in preparing for BIG LIFT, has not yet been thoroughly tested but promises to achieve a satisfactory state of materiel readiness. Periodic tests of randomly selected vehicles

SUMMARY

would verify this state, determine the deterioration rate, and indicate any changes required in the prescribed maintenance level. This also applies to storage in controlled humidity.

6. The current organization of the custodial group (after 1 Apr 64) is more mission-oriented, and excess overhead has been eliminated. The manning appears to be in consonance with the new workload.

7. Prepositioned vehicles of the model currently distributed in active units performed as well as or better than those in the active units. The modernization of the prepositioned vehicular fleet approved by DA is justified on the basis of performance during BIG LIFT. The prepositioned vehicles should be of the type common to the theater. Warehousing of nonvehicular equipment appears satisfactory, since only negligible failures were reported during the exercise.

8. The present plan for troop disposition when the custodial group is deactivated is general and does not take advantage of the potentialities of this group of trained technicians. The resident divisions might relish the opportunity to earmark the military occupational specialties (MOSs) in the group for immediate assignment on release when the issue mission is accomplished.

9. Utilization of locally procured labor to release military spaces is a means of managing allotted manpower to the best advantage without jeopardizing the custodial mission.

10. Although some progress has been made, the facilities for custodial maintenance still verge on the inadequate.

11. The custodial group must still use prepositioned tools for the accomplishment of its maintenance mission. This condition will become most acute when the organizational mechanics are phased in and are issued these tools. The services of the custodial mechanics, without tools, will be seriously curtailed.

RECOMMENDATIONS

1. The readiness conditions of the prepositioned materiel should not be compromised by reducing or postponing maintenance effort.

2. A study should be initiated by Seventh Army Special Staff to determine (a) the composition of a prepositioned portion of the division slices, (b) the supply level to be maintained, (c) the necessary augmentation of the custodial group, and (d) the proper phasing-in of the slice and division maintenance personnel.

3. Measures should be taken to assure early transmission of warning to the custodial groups.

4. Preselection of wartime dispersal areas should be made and movement plans should be adjusted to take cognizance of the necessary movements to these areas; planning should include predesignation of rear-area units to assist in the dispersal.

5. Prepositioned materiel should be subjected to periodic small-scale readiness tests to adjudge the proper maintenance level.

6. The active divisions should be given an opportunity to designate by MOS the spaces they would absorb from the custodial group in an emergency.

7. Cognizance should be taken of the use of locally procured labor personnel for the custodial mission.

8. Rehabilitation of the maintenance facilities of the custodial group should be accelerated within the means available.

9. The current table of distribution (TD) of the custodial group should be accompanied by an appropriate table of allowances (TA), particularly for mechanics' tool kits.

10. Prepositioned equipment should be standardized with equipment current in the theater.

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Study of the Prepositioning Concept: Operation BIG LIFT Final Report

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ABBREVIATIONS

acft	aircraft
armd div	armored division
AGC*	airfield control group(s)
AMG*	Armored Maintenance Group
ammo	ammunition
APC	armored personnel carrier
ARG*	Augmentation Readiness Group
armd	armored
armt	armament
arty	artillery
AOSL	authorized organizational stockage list
ASL	authorized stockage list
bn	battalion
CH*	controlled-humidity (storage)
CONUS	continental United States
CSMG*	Combat Support Maintenance Group
DA	Department of the Army
DOD	Department of Defense
DX	direct exchange
FTX	field training exercise
Hq	headquarters
IMG*	Infantry Maintenance Group
inf	infantry
JCS	Joint Chiefs of Staff
maint	maintenance
MCC	Movement Control Center
mech	mechanic; mechanized
m-hr*	man-hours
MOS	military occupational specialty
MWO	modification work order(s)
na	not available
NATO	North Atlantic Treaty Organization
OCC*	Ordnance Control Center
OEM	on-equipment materiel
OH*	overhead
ord	ordnance
pax	passengers
POL	petroleum, oils, and lubricants
POM	preparation for oversea movement (units)
Q*	quarterly inspection
QM	quartermaster
RACFOE*	Research Analysis Corporation Field Office, Europe
R-F*	field maintenance repair requirement also affecting readiness
RFI	ready for issue
ROAD	Reorganization Objective Army Divisions
ROCAD*	Reorganization of the Combat Armored Division
ROCID	Reorganization of the Combat Infantry Division
R-O*	organizational repair requirement affecting readiness of the vehicle
S*	semiannual inspection
SACC*	Staging Area Control Center
SOP	standing operating procedures
sig	signal
SP	self-propelled
TA	table of allowances
TD	table of distribution
TI	technical inspection
TOE	table(s) of organization and equipment
trans	transportation
UPI*	utilization of potential index
USSTRICOM*	United States Strike Command
WVE*	wheeled-vehicle equivalent

*Nonstandard abbreviation, not listed in AR 320-50.[3]

INTRODUCTION

PREPOSITIONING PRIOR TO BIG LIFT

Background of Prepositioning

The origin of the prepositioning concept, its implementation prior to Operation BIG LIFT, and the problems arising from the implementation are presented in "Study of the Prepositioning Concept prior to BIG LIFT (U),"[1] an earlier RACFOE publication. Performance evaluation prior to BIG LIFT rested on the observation of relatively few vehicles, whereas BIG LIFT offered an opportunity for a large-scale test. The two situations differed so radically that it was thought advisable to present the study in two parts, as represented by RAC-TP-140(FOE)[1] and this paper, which evaluates prepositioning from performance data generated during Operation BIG LIFT.

A preliminary analysis of the accumulated data was furnished Seventh Army in the RACFOE publication, "Interim Evaluation of the Prepositioning Concept—Operation BIG LIFT (U)."[4] This report was prepared in order to be contemporaneous with other after-action reports and to assist Seventh Army in the preparation of its after-action report. The interim evaluation served its purpose and received constructive criticism from Seventh Army staff sections and a RAC review board, and it has been used as the framework for this report. The analysis has been updated and expanded to include the preparation for restorage—although this phase has not been completed.

With the exception of the individual equipment in the hands of the CONUS-based troops, some tank recovery vehicles, and all divisional aircraft, all the equipment of the Reorganization of the Combat Armored Division (ROCAD) 2d Armd Div and the Reorganization of the Combat Infantry Division (ROCID) 4th Inf Div was prepositioned at various sites in or west of the Rhine valley. Class I nonperishable rations were also prepositioned, but class III and class V were put in rotational storage (stockage level increased but supplies rotated to minimize deterioration).

When the reorganization of the divisions under the ROAD "E" Series Tables of Organization and Equipment (TOE) was started, the prepositioned ASL and the AOSL were considerably short, i.e., only 50 percent of the ASL and 25 percent of the AOSL were on hand on 8 Jul 63,[5] based on a 45-day stockage level. After a major requisitioning effort the 2d Armd Div took the field with 85 percent ASL and 77 percent AOSL on 24 Oct 63.[5]

All vehicles were in outside storage and the bulk of the remaining materiel was in covered storage, warehoused in segregated lots for the individual companies. Some of the materiel remained in depot pack until issue and the rest were given periodic surveillance inspections with repair or replacement as found necessary, e.g., mildew on canvas and decay in ax handles.

Signal electronic equipment was checked periodically and the engines of the Signal and Engineer generators and the automotive equipment were exercised biweekly. All maintenance procedures were prescribed by Seventh Army.[6]

The automotive fuel-consuming vehicles constituted the only equipment with comprehensive maintenance records; for this major reason and with the concurrence of the project advisor the investigation was conducted almost solely on this equipment.

Maintenance Situation prior to BIG LIFT

The maintenance situation prior to BIG LIFT has been reported in detail in a previous publication,[1] and the following abstract of the data contained therein is furnished as background material to this report.

Organization. The custodial force, with the mission responsibility for prepositioned-equipment readiness, was organized into three TD groups: the AMG, whose equipment was to be issued to the 2d Armd Div (used in BIG LIFT); the Infantry Maintenance Group (IMG), which had custody of the equipment of the 4th Inf Div (ROCID); and the Combat Support Maintenance Group (CSMG), which had custody of the equipment of the 10 combat-support elements, with no headquarters and with appropriate segments attached to the two major maintenance groups.

The groups were organized operationally rather than functionally and so the TDs were not mission-oriented. The obstacles inherent in such organization had been partially overcome by retraining personnel and assigning personnel to other-than-MOS duty, but requests were still being made by the groups for revision of the TDs to conform more nearly to the mission. With the advent of BIG LIFT and the augmentation of the AMG by some 700 personnel, the workload was such that no action was possible on reorganization during the BIG LIFT period. The reorganization was finally accomplished 1 Apr 64 (see the section "Evaluation") but BIG LIFT was handled by the then current organization, augmented.

Maintenance Procedures. Prior to BIG LIFT the prescribed maintenance procedure consisted principally of surveillance and biweekly exercise of the rolling stock. Some of the equipment of the IMG had been issued to LONG THRUST units and had undergone preissue and turn-in Q inspections[7] and repair of some 800 automotive vehicles. In 1963 a packaging and preservation team, after an investigation in the theater, recommended storing the prepositioned materiel in controlled-humidity (CH) warehouses. Subsequently, AR 700-28[8] directed preferential use of this method. Comment on the efficiency of this method is beyond the scope of this report.

In the AMG, small increments of about 20 vehicles were given road marches of approximately 100 miles and were then given the Q inspection and returned to storage. This type of operation was designated "SHORT THRUST I" and involved no more than 300 vehicles.

The biweekly exercise was designed to disclose observable deficiencies of the vehicles, with organizational and field-maintenance corrections to follow.

Many of these discovered deficiencies remained uncorrected; a large part of this was attributed to faulty requisitioning procedures. Preparation for BIG LIFT showed that a great many deficiencies remained undiscovered in this procedure (see the section "Initial Phase and Operational Readiness").

With BIG LIFT alert, the AMG started a series of road tests of the vehicles, called "SHORT THRUST II," which was discontinued after two weeks because of potential damage to the vehicles. On 22 Jul 63 the commanding officer of the combined groups, appointed for the BIG LIFT operation, introduced a maintenance program considerably greater in extent than the previously prescribed program (described in more detail in the section "Preparatory Maintenance of Vehicles").

GENERAL OBJECTIVES OF THE STUDY

On the basis of the experience gained in the study of prepositioning prior to BIG LIFT it was felt necessary to limit the scope of the project to reflect the capabilities of the small study group within the time permitted. Accordingly the general objectives of the study were modified to (a) make a comparative analysis of the performance and reliability of prepositioned vehicles and typical theater vehicles; (b) analyze the magnitude of organizational and field maintenance required to maintain the prepositioned materiel; (c) evaluate the arrival, staging, and deployment processes and the theater support required in each; (d) evaluate the reliability of certain high-density items in the division TOE, from all Technical Services, as a check on warehousing procedures; and (e) make a general evaluation of the implementation of the concept of prepositioning.

OUTLINE OF OPERATION BIG LIFT

This operation involved the deployment by air of the personnel and individual equipment of the entire 2d Armd Div with attached nondivisional combat-support battalions (two artillery and one composite transportation) from CONUS to Europe, drawing prepositioned equipment on arrival in Europe. Officially the exercise was conducted during the period 19 Oct–4 Dec 63[9] and the airlift was conducted "during a period of tension." The principal purpose of the operation, as announced by the Joint Chiefs of Staff (JCS) was "to demonstrate the United States' capability to airlift forces to reinforce NATO rapidly."[10]

The operation was also intended to accomplish the following purposes:

(1) To test and improve contingency plans involving the rapid reinforcement of NATO with CONUS-based forces.

(2) To evaluate and gain experience in the drawing and utilization of prepositioned Army equipment.

(3) To train participating Army and Air Force forces in rapid overseas deployments.[9]

In addition to the actual participating forces, the concurrent deployment of the 4th Inf Div, one tank battalion, one artillery battalion, and two engineer battalions was simulated.

Planning for the operation was initiated by the US Strike Command (USSTRICOM) on 25 Jun 63[9] in compliance with a JCS directive,[11] and the final operations plan was published 27 Sep 63.[12]

Although preliminary messages had been exchanged earlier, formal planning in Seventh Army started at the same time and the Seventh Army Operations Plan was published 15 Sep 63.[13] Preparation of the prepositioned equipment started about 8 Jul 63 and continued until issue to the incoming troops, completed 24 Oct 63.

After marry-up with the equipment, the division and attached units participated in an FTX, in which the aggressor force was played by the 3d Armd Div, reinforced. On the way to the assembly area, two battalions from 2d Armd Div tested the swimming capabilities of the prepositioned APCs, 27–28 Oct 63, without incident.[14,15] The scenario of the FTX is not pertinent to this report.

The FTX terminated 5 Nov 63 and the equipment was returned to the prepositioned storage sites during the period 6–12 November. During the march back to the storage areas a portion of the crew-served weapons were test-fired at the Baumholder firing range, with generally satisfactory results.[15] Redeployment of the main body commenced 12 November and closed at home stations in CONUS on 23 Nov 63.[9] A rear party of 557 remained in Europe, assisting in turn-in of equipment; the last elements departed on 4 December.

DATA COLLECTION

Composition of the Teams

In anticipation of the huge body of data to be generated by BIG LIFT, a request was made to Seventh Army that the RACFOE study team of two analysts be augmented by 20 officers and 40 enlisted men during the exercise, for the purpose of collecting data from seven selected units in each division. Two additional analysts were requested from RAC for temporary duty in connection with the reduction of those data. Both requests were approved and appropriate orders were issued, attaching individuals and transportation to the study team for the period of the exercise. The composition of the data-collection team and its assignments are shown in App A.

Subteams were assigned to similar units in both 2d Armd Div and 3d Armd Div as follows: cavalry squadron, maintenance battalion, supply and transport battalion, artillery battalion, two armor battalions, and a mechanized battalion.

The remaining subteams were used for liaison with supporting ordnance units, administration, and liaison with the 14 basic subteams. Accumulated data were to be collected daily and brought to headquarters for processing. The control unit was to identify gaps and to dispatch liaison teams for additional information or to assist in emergencies.

The basic teams covered approximately 25 percent of the divisional equipment and the ordnance liaison teams acquired third-echelon data on the entire two divisions.

Data Collection for Automotive Equipment

Forms were designed to assist in the collection and, early in September, the team members were assembled and given a week's training in the use of the forms and the objectives of the study. Primary emphasis was placed on automotive vehicles (i.e., excluding trailers) for these reasons: (a) they constituted the bulk of the prepositioned equipment, (b) record-keeping was more thorough, (c) observation was easier and could be verified through multiple sources, and (d) usage was mandatory and was measurable. Records for most of the remaining equipment were either nonexistent or relatively sparse.

Composition of the Vehicle Fleets

The automotive equipment used by the 2d Armd Div was furnished from several sources. The AMG was in prepositioned ROCAD (TOE-17D) configuration and had not acquired all the necessary vehicles for the ROAD (TOE-17E) configuration. The IMG furnished 241 vehicles; the CSMG depots and lateral transfer completed the fleet. Although the combined authorization was for 4176 vehicles, 4665 vehicles were used, of which 4229 were issued and 436 were placed in the maintenance float maintained by supporting ordnance units. Only the powered vehicles issued initially by the AMG to the division were studied in the following analysis; float, IMG, CSMG, trailers, and vehicles from other sources were excluded. The composition of the 2d Armd Div fleet and float is shown in Table 1.

The corresponding 3d Armd Div equipment is designated in Table 2. Only divisional equipment is enumerated and no float or combat-support vehicles are included.

Other Equipment

As a check on materials in storage the subteams were required to report deficiencies in the units to which they were assigned on several high-density or critical items, as follows:

(a) Engineer items: magnetic lensatic compass; right-angle flashlight; gas-engine generator set, all types.

(b) Ordnance items: binoculars, all types; general mechanic's tool kit; wrist watch.

(c) Quartermaster items: single-bit ax, all types; oil-stove burner, tent; field cook set; space heater; shovel, all types; gasoline stove, one-burner; table, folding legs.

(d) Signal items: radiacmeter, all types; radio set, all types; telephone set, all types; tool equipment, all types.

(e) Special-attention items: tents and paulins, all types.

Basis for Comparison

The basis for comparison of the performance of vehicles in the 2d Armd Div and the 3d Armd Div was the assumption that the 3d Armd Div accomplished the maintenance function in a manner representative of the behavior of the typical Seventh Army unit in the field. Personnel were familiar with their equipment, performed driver and organizational maintenance as prescribed,

TABLE 1

Quantity of Automotive Equipment in Support of 2d Armd Div

Equipment and class	ROAD div and spt, TOE authorized	Actual[a] issue to 2d Armd Div +	Float[a] in hands of ordnance support	Vehicles prepared				Vehicles in initial sample[c]
				AMG[5] on hand	IMG[b] by lateral transfer	Combat support and other sources	Total issue + float	
Wheeled								
¼-ton—M38,[d] M170	972	1069	123	893	127	172	1192	259
¾-ton—M37, M43	597	653	78	390	34	307	731	121
2½-ton—M34, M35, M109, M49, M275	1078	942	115	604	37	416	1057	367
5-ton—M54, M51, M139, M52, M246, M543	436	434	54	369	16	103	488	145
10-ton—M123	16	24	1	6	1	18	25	5
Total	3099	3122	371	2262	215	1016	3493	897
Tracked								
Tank—M48,[d] M88	411	398	23	411	10	–	421	162
APC—M59,[d] M84	558	571	38	593	16	–	609	173
SP artillery—M52, M44, M55	76	106	4	70	–	40	110	18
Total	1045	1075	65	1074	26	40	1140	353
Miscellaneous	32	32	–	–	–	32	32	–
All vehicles	4176	4229	436	3336	241	1088	4665	1250

[a]Data from Ordnance Control Center (OCC).
[b]Data from Hq IMG.
[c]Total number of vehicles in the seven sample units.
[d]Equipment differs from 3d Armd Div equipment.

TABLE 2

Quantity of Automotive Equipment in 3d Armd Div

Equipment and class	Vehicles in ROAD TOE	Vehicles in initial sample[a]
Wheeled		
¼-ton—M151,[b] M170	976	247
¾-ton—M37, M43	598	100
2½-ton—M34, M35, M109, M49, M275	883	273
5-ton—M52, M51, M543, M54, M139, M246	444	139
10-ton—M123	16	6
Total	2917	765
Tracked		
Tank—M60,[b] M88	477	157
APC—M113,[b] M84	654	164
SP artillery—M52, M44, M55	76	18
Total	1207	339
Miscellaneous	32	–
All vehicles	4156	1104

[a]Total number of vehicles in the seven sample units.
[b]Equipment differs from 2d Armd Div equipment.

kept routine records, and operated in a normal manner. The automotive-equipment performance in 3d Armd Div could thus be used as the theater standard against which comparisons could be made. For convenience the data-collection effort was arranged to correspond to the identifiable phasing of BIG LIFT, which was combined into three phases for reporting purposes.

BIG LIFT Phases

The time phasing for the 2d Armd Div operations was more distinct and identifiable than for the 3d Armd Div, which was in normal garrison operation before BIG LIFT and reverted to the same status afterwards. Thus the 3d Armd Div phasing can be identified only by corresponding time periods.

Preparatory. The preparatory phase, which started 8 Jul and ended 24 Oct 63, was regarded as identical in both divisions so that a comparison could be made more easily. The 2d Armd Div personnel were not involved in this phase.

Airlift. The airlift phase started 22 Oct and ended 24 Oct 63. The personnel of the 2d Armd Div were airlifted in this period and the necessary reception support was furnished by Seventh Army. This phase was not applicable to the 3d Armd Div.

Staging. The staging, or marry-up, phase started with the arrival of troops on 22 Oct and ended with the final issue, completed on 24 Oct 63. Like the airlift, this phase was not applicable to the 3d Armd Div.

March to Forward Assembly Area. This phase started 25 Oct and ended with all troops in initial position on 29 Oct 63. In the 2d Armd Div this march was closely followed by movement control center (MCC), staging area control center (SACC), OCC, and observers from interested agencies within the DOD. Although some observers followed the 3d Armd Div, it was not scrutinized nearly as minutely.

FTX. This phase started on 30 Oct and ended 5 Nov 63. Data collection became difficult as units separated under combat conditions. There is evidence that some repairs were unrecorded in both divisions and that a number of other repairs were deferred.

Return March. The return-march phase started 6 Nov and ended with the last unit at home station or storage site on 12 Nov 63. Again repair deferral was considerable, with many disabled vehicles towed to home station.

Turn-in. This phase started 6 Nov with the arrival of troops at the storage sites and ended approximately at the end of November 1963. During this phase the 2d Armd Div main body was airlifted back to CONUS and the remaining turn-in was assigned to a rear echelon. This phase was not applicable to the 3d Armd Div.

Preparation for Restorage. This phase started about 8 Nov and was still in process as of July 1964, when data collection was terminated. In 2d Armd Div it was not nearly as clear and distinct as the other phases. LONG THRUST exercises were resumed and some vehicles had to be prepared by the maintenance group for further field duty. The modernization of the prepositioned vehicular fleet was started at about the same time and many vehicles were turned in to depot in an "as is" condition, with necessary repairs unaccomplished. In the 3d Armd Div, normal maintenance practice was resumed.

Summary. The total maneuver took 15 days with 9 to 10 days of vehicle movement during that time. The airlift of the 2d Armd Div to CONUS was not studied. In 2d Armd Div the repairs required during the preparation for restorage were taken as resulting from the exercise, and in 3d Armd Div every vehicle was given a postexercise inspection within 3 weeks (as they were needed for continued use). All repairs during this interval were considered due to BIG LIFT. Although the phasing outlined above was useful initially in identifying activities of both divisions, that usefulness has lessened and this report confines its results on vehicular maintenance and performance to the preparatory phase and the maneuver phase; the latter was a consolidation of both marches, the FTX, and the required postexercise restorage phase. Where necessary, the original phasing is used to discuss incidents occurring in a particular phase and the data-collection techniques used.

INITIAL PHASE AND OPERATIONAL READINESS

PREPARATORY MAINTENANCE OF VEHICLES

Maintenance Procedure Adopted

Preparation of the prepositioned equipment for BIG LIFT started 8 Jul 63. Initially, SHORT THRUST II vehicles were road-tested directly from the park; the correction of observed deficiencies was scheduled to follow that test. It became apparent that this procedure was not satisfactory, and a new procedure, introduced jointly by the AMG and supporting Ordnance 22 Jul 63,[16] was followed until issue of the vehicles to the 2d Armd Div on 22–24 Oct 63. It consisted of the following four stages for each vehicle: (a) semiannual inspection (S) service[7] performed by AMG personnel; (b) road exercise of 25 miles for tracked vehicles and 50–60 for wheeled vehicles by AMG; (c) technical inspection (TI)[17,18] by Ordnance personnel; and (d) correction of remaining deficiencies, followed by a short road test after which the vehicles were RFI.

Maintenance Effort for BIG LIFT Vehicles

The 344 organic mechanics in AMG were augmented by 440 from IMG and other Seventh Army units and jointly worked 390,000 m-hr. The 134 AMG drivers, augmented by an additional 164, put in 81,000 m-hr,for a total of 471,000 m-hr.[15] Training requirements were waived during the preparatory phase.[16] Ordnance reported 619,000 m-hr required (exclusive of ammo handling)[15] for third-echelon repairs, concomitant second-echelon repairs, supervision, TIs, application of essential MWOs, and processing of requisitions for completion of the division ASL/AOSL and for repair parts needed by the AMG and Ordnance shops. If the wheeled vehicle and its companion trailer are counted as a single unit, 4665 vehicles were processed, including those assigned to the maintenance float (see Tables 1 and 2).

Within the AMG the 471,000 m-hr represents 101 m-hr for organizational maintenance per vehicle, not including overhead. Records of third-echelon repairs show an average of 9 m-hr (8.67 m-hr in the sample and 9.3 m-hr in the after-action report)[19] for each repair action, or approximately 5 m-hr/vehicle average, including TIs. Including overhead of the old TD at 37 percent, the time available for the average vehicle was 143 m-hr. This is considered a minimal value because it does not include organizational maintenance performed by Ordnance at the staging areas after prepositioned tools were issued.

Technical Inspections and Vehicle Condition

A detailed study was made of the TIs performed on 2001 wheeled vehicles and on 703 tracked vehicles of all types at Pirmasens and Kaiserslautern. Typical deficiencies recorded on Form 2404 during these TIs are given in Tables 3 and 4. Deficiencies were designated as "O" (organizational repair requirement), "R-O" [organizational (second-echelon) repair requirement, affecting readiness of the vehicle], and "R-F" [field-maintenance (third-echelon) repair requirement, also affecting readiness]. Distributions of deficiencies by vehicle types as taken from the TI forms are shown in Figs. 1 to 14 and the distributions of type deficiencies are shown in Tables 5 and 6. Records of the S services are not complete but the typical deficiencies and number of deficiencies are of the same order as those found during the Ordnance TIs.

Of the 2704 vehicles studied, approximately 25 percent, or 487, of the wheeled vehicles and approximately 20 percent, or 137,of the tracked vehicles actually received third-echelon repair. Details are given in Table 7.

Using as the criterion of operational readiness that a vehicle be started and moved past a designated starting-point, about 94 percent of the vehicles before preparation could have been driven and passed the starting-point. As was later shown by BIG LIFT, reliability would have been low. In the light of BIG LIFT experience this criterion [used in RAC-TP-140(FOE)[1]] is not quite satisfactory because it is almost independent of reliability; it will not be used in the remainder of this report. By a materiel-readiness criterion (readiness deficiencies as reported in the TIs—a much more meaningful criterion), operational readiness was much lower, i.e., closer to 25 percent. The only logical conclusion is that the maintenance program in effect up to July 1963 was not adequate, either in substance or in application. It will be shown in the next section that the maintenance effort made during the period July–October 1963 corrected this condition so that, by any criterion, operational readiness was higher than 98 percent on 24 October when the 2d Armd Div started the march to the assembly area.

By way of comparison, sample units in 3d Armd Div reported an average of 11.5 m-hr/Q inspection on wheeled vehicles and 20.5 m-hr on tracked vehicles in the quarter preceding BIG LIFT (August–October 1963), an average of 18.5 m-hr per vehicle—or, if overhead is included, approximately 25 m-hr. Allowances must be made for the fact that conditions were not exactly comparable. Operational readiness is a continuous program in 3d Armd Div and the vehicles are operating daily. Maintenance prior to August consisted of similar Q inspections and repair and continuing first-echelon inspections, so that the vehicles were operating satisfactorily when they entered the quarter prior to BIG LIFT. Some notion of the condition of these vehicles can be obtained from the third-echelon comparative data on average repair times on vehicles repaired during this quarter, as shown in Table 8. These data were derived in the manner shown in Table 7.

Operational Readiness after Preparatory Maintenance

In BIG LIFT, operational readiness of vehicles was determined first by counting the number of readiness-item repairs necessary in the staging area

TABLE 3

Typical Deficiencies of Wheeled Vehicles

Location of deficiency	Kind of deficiency													
	Inoperative	Improper mounting	Unserviceable	Component missing	Adjustment	Loose	Broken	Leaking	Low or dirty	Rusty	Requires service	Frozen or sticking	Requires tuning	Noisy
Instruments	Fuel gage, oil gage	Radio indicator	—	—	—	Instrument panel								
Accessories	—	—	Windshield wiper, horn	Windshield wiper, mirror	Windshield wiper	Windshield wiper								
Lamps	—	Wiring, blackout wire, slave receptacle	Stoplight, blackout stoplight, taillight, switch, headlight, slave receptacle											
Engine	—	Spark plug cable, primary wire	Fan belt, cylinder, vacuum lines, oil sending unit	Line holddown, fuel-pump handle, accelerator pedal boot, distributor-cap screw, throttle cable	Choke cable	Tappets, distributor, primary wire, ignition switch, mounting, sending unit, vacuum lines, fan shroud, throttle cable, stabilizer	Voltage-regulator seal	Oil filter, fuel pump, side cover, fuel gasket	Oil, air cleaner	—	—	Throttle, crankshaft pulley	Engine	
Steering	—	—	Idler arm bushing, steering gear, bell crank bushing	Tie-rod fittings	—	Drag link, bolts, bell crank bushing	—	Steering gear						
Clutch	—	—	Cable boot, clutch	Clevis pin	Clutch	Link	—	—	—	—	—	—	—	Bearing
Brakes	—	Antirattle spring	Ratchet, link bushing, handle	Antirattle spring, master-cylinder boot, brake line	Hand brake, service brake	Drum	—	Master cylinder						
Generator-starter	—	—	Starter cable	—	—	Mounting bolt, wire, connector								
Power train	—	—	Transfer lever boot	—	—	Transfer bolts, transmission bolts	—	Transfer seal, transmission seal, shifter-shaft seal						
Suspension-drive	—	—	—	—	—	Spring shackle, cross member, prop-shaft bolts, power-takeoff cover	—	Axle seal, differential seal	Differential vent	Constant-velocity joints				
Tires	—	—	—	Valve cap, lug nut, lubrication fittings	—	Tire	—	—	Tire					
Battery	—	Holddown	—	Grommets	—	Cable	—	—	Battery	—	Battery			
Crankcase	—	—	—	Hose clamp, air-cleaner clamp	—	Breather	—	—	—	—	Air cleaner			
Radiator	—	—	Brace	Gasket	—	Mounting	—	Hose	Coolant	—	Radiator			
Pumps, belts, pulleys	—	—	—	—	—	Fan belt								
Ignition	—	—	Spark plug, secondary wire	—	—	Secondary wire, distributor								
Carburetor	—	—	Fuel pump	Fuel-line screw,	—	—	—	Fuel line						

		ceptacle	switch, headlight, slave receptacle											
Engine	—	Spark plug cable, primary wire	Fan belt, cylinder, vacuum lines, oil sending unit	Line holddown, fuel-pump handle, accelerator pedal boot, distributor-cap screw, throttle cable	Choke cable	Tappets, distributor, primary wire, ignition switch, mounting, sending unit, vacuum lines, fan shroud, throttle cable, stabilizer	Voltage-regulator seal	Oil filter, fuel pump, side cover, fuel gasket	Oil, air cleaner	—	—	Throttle, crankshaft pulley	Engine	
Steering	—	—	Idler arm bushing, steering gear, bell crank bushing	Tie-rod fittings	—	Drag link, bolts, bell crank bushing	—	Steering gear						
Clutch	—	—	Cable boot, clutch	Clevis pin	Clutch	Link	—	—	—	—	—	—	—	Bearing
Brakes	—	Antirattle spring	Ratchet, link bushing, handle	Antirattle spring, master-cylinder boot, brake line	Hand brake, service brake	Drum	—	Master cylinder						
Generator-starter	—	—	Starter cable	—	—	Mounting bolt, wire, connector								
Power train	—	—	Transfer lever boot	—	—	Transfer bolts, transmission bolts	—	Transfer seal, transmission seal, shifter-shaft seal						
Suspension-drive	—	—	—	—	—	Spring shackle, cross member, prop-shaft bolts, power-takeoff cover	—	Axle seal, differential seal	Differential vent	Constant-velocity joints				
Tires	—	—	—	Valve cap, lug nut, lubrication fittings	—	Tire	—	—	Tire					
Battery	—	Holddown	—	Grommets	—	Cable	—	—	Battery	—	Battery			
Crankcase	—	—	—	Hose clamp, air-cleaner clamp	—	Breather	—	—	—	—	Air cleaner			
Radiator	—	—	Brace	Gasket	—	Mounting	—	Hose	Coolant	—	Radiator			
Pumps, belts, pulleys	—	—	—	—	—	Fan belt								
Ignition	—	—	Spark plug, secondary wire	—	—	Secondary wire, distributor								
Carburetor	—	—	Fuel pump	Fuel-line screw, fuel-pump vent	—	—	—	Fuel line						
Exhaust system	—	—	Muffler, tailpipe, manifold, gasket	—	—	—	—	Connection, manifold						
Wheels	—	—	—	—	—	Lug nuts, bearings	—	—	—	—	Bearings			
Hardware-canvas	—	Fuel line, fording-valve cable, seat	Fuel-tank grommet, accelerator-pedal boot, heater hose, windshield	Fuel-tank strainer, lift shackle, seat, antenna mounting, gas-cap chain, seat bracket, floor boards, screw, speedometer grommet, hood latch, seat lock	—	Body bolts, cross member, oil filter, spare tire lug	Canvas, cushion, fender, spare-tire bracket, reflector, body, radiator grill, hood, tail gate, frame, bumper	Fuel tank	—	—	Paint			

TABLE 4

Typical Deficiencies of Tracked Vehicles

Location of deficiency	Kind of deficiency												MWO
	Inoperative	Improper mounting	Unserviceable	Component missing	Adjustment	Loose	Torn, bent, or broken	Leaking	Low or dirty	Rusty	Requires service	Frozen or sticking	
Instruments	Moisture in tachometer, transmission-radiator light, tachometer, oil gage	Temperature gage, speedometer cable, tachometer cable	—	Oil-pressure light, tachometer	—	—	—	—	—	—	—	Starter button, battery generator indicator	
Lamps	Clearance light, service lights, infrared	—	Moisture in clearance light	Taillight door screw, taillight screw, blackout-light grommet	—	Dome light screw, searchlight ground wire	Clearance light frame, light guard, infrared lens						
Engine	Throttle, fuel shutoff, starter, both engines	Wrong top flywheel inspection cover, improper air hose, neutral start switch not connected, wrong air-cleaner bolt, muffler shield	Worn motor mount, timing chain hits cover	Governor seal, choke-return spring, vacuum-line seal, accessory-drive lubrication tubes, air-cleaner clamp, distributor-cap screw, neutral start switch, oil-filter mounting bolt	Idle, synchronize engine, engine misfire	Spark plug cables, breather hose, governor housing, starter cable, neutral start switch wires, air-cleaner hose, oil filter, V-belts, accelerator linkage lock nuts, carburetor hose	Starter solenoid mounting bolt, fuel tank vent line	Primer pump, valve-cover gasket, engine at drain plug, between engine and transmission	Engine oil low, dirty oil	Gas caps	Overfull engine oil, drill holes in bell housing	—	9-2300-203-30/2
Suspension	—	—	Worn-out shocks, worn-out track pads	—	—	End connector, shock absorber mounting bolts, lug nut, loose pads	Shock-absorber pin, end connector	—	—	—	—	—	9-2300-202-20
Brakes	Steering lock	Brake lock	—	Steering	Brake linkage, brakes	Brake bands, brake linkage lock nuts, brakes							
Power train	Nonshifting transmission	Transmission heat shield, shifting pin and linkage	—	Transmission heat shield	Synchronize transmission	Shift linkage bolt, differential linkage lock nuts	—	Differential sending unit, transmission	Transmission oil, low differential oil, right-angle drive oil, low final-drive oil, water in final-drive oil	—	Overfull transmission, overfull differential, relocate check-level pipe	—	9-2300-203-20/3
Auxiliary shaft bearing	—	—	Noisy										
Auxiliary (engine)	Nonstarting engine, hand crank	Choke	Exhaust pipe, breather hose	Exhaust-pipe clamp, muffler	Engine misses	Ground strap, exhaust pipe	Choke cable, hand-start cable	—	Engine oil	—	Overfull oil		
Openings and plugs	Driver's heater, seat lock	Spare-tank release cable, driver's escape hatch, fire-extinguisher hose, periscope seals, gear-box cover, tent frame	—	Ramp-door rubber, cupola canvas, shroud bolt, drain plugs, roller on driver's hatch, straps, gun-shield canvas, driver's escape-hatch pin, crash pad, fording plugs	—	Cable mounting housing, deck bolts, shift turner panel bolts, hatch handle, hydraulic line shield, fuel tank grommet	Fender, fender bolt, fender brace, mortar-mount handle, splash guard, reflector	—	Low fuel tank	—	Overfull inside track, gasoline in hull, frayed ramp cable, spot paint	—	9-2300-203-30/1
Cupola and turret	Computer motor, reticle knobs, commander's override pump switch, cupola-hatch lock, elevation quadrant	Fire extinguisher, tilted reticle, cupola azimuth lock, periscope box, radio shield, cupola feed	Cupola vision block, nonclosing breech, commander's ready light, cupola azimuth lock,	Fire extinguisher, cupola power line, lacing wire, gunner's seat pad, gun-shield clamp, traversing hand guard,	Traversing mechanism backlash, commander's override linkage, gunner's control	Fire-extinguisher mounting bracket, range finder, cupola lock bolts, M13 quadrant elevator, machinegun caution plate, blast deflector	Cupola pin lock, filler cap chain, firing harness insulation, machinegun bracket	Replenisher	Hydraulic oil	Periscope mount, infrared knob	Purge range finder, ring gear fitting, recharge accumulator, repack breech lock bearing, recoil blast	Binding travel lock, intercommunication station knobs on radio frequency	9-1005-219-30/2 9-1005-219-30/1 9-1005-219-30/6 9-1005-227-30/7

				oil-filter mounting bolt		hose							
Suspension	—	—	Worn-out shocks, worn-out track pads	—	—	End connector, shock absorber mounting bolts, lug nut, loose pads	Shock-absorber pin, end connector	—	—	—	—	—	9-2300-202-20
Brakes	Steering lock	Brake lock	—	Steering	Brake linkage, brakes	Brake bands, brake linkage lock nuts, brakes							
Power train	Nonshifting transmission	Transmission heat shield, shifting pin and linkage	–	Transmission heat shield	Synchronize transmission	Shift linkage bolt, differential linkage lock nuts	—	Differential sending unit, transmission	Transmission oil, low differential oil, right-angle drive oil, low final-drive oil, water in final-drive oil	—	Overfull transmission, overfull differential, relocate check-level pipe	—	9-2300-203-20/3
Auxiliary shaft bearing	—	—	Noisy										
Auxiliary (engine)	Nonstarting engine, hand crank	Choke	Exhaust pipe, breather hose	Exhaust-pipe clamp, muffler	Engine misses	Ground strap, exhaust pipe	Choke cable, hand-start cable	—	Engine oil	—	Overfull oil		
Openings and plugs	Driver's heater, seat lock	Spare-tank release cable, driver's escape hatch, fire-extinguisher hose, periscope seals, gear-box cover, tent frame	—	Ramp-door rubber, cupola canvas, shroud bolt, drain plugs, roller on driver's hatch, straps, gun-shield canvas, driver's escape-hatch pin, crash pad, fording plugs	—	Cable mounting housing, deck bolts, shift turner panel bolts, hatch handle, hydraulic line shield, fuel tank grommet	Fender, fender bolt, fender brace, mortar-mount handle, splash guard, reflector	—	Low fuel tank	—	Overfull inside track, gasoline in hull, frayed ramp cable, spot paint	—	9-2300-203-30/1
Cupola and turret	Computer motor, reticle knobs, commander's override pump switch, cupola-hatch lock, elevation quadrant light, cupola electrical system, machinegun solenoid	Fire extinguisher, tilted reticle, cupola azimuth lock, periscope box, radio shield, cupola feed assembly	Cupola vision block, non-closing breech, commander's ready light, cupola azimuth lock	Fire extinguisher, cupola power line, lacing wire, gunner's seat pad, gun-shield clamp, traversing hand guard, switch cover, commander's latch pin	Traversing mechanism backlash, commander's override linkage, gunner's control linkage	Fire-extinguisher mounting bracket, range finder, cupola lock bolts, M13 quadrant elevator, machinegun caution plate, blast deflector	Cupola pin lock, filler cap chain, firing harness insulation, machinegun bracket	Replenisher	Hydraulic oil	Periscope mount, infrared knob	Purge range finder, ring gear fitting, recharge accumulator, repack breech lock bearing, reseal blast deflector, paint on periscope	Binding travel lock, intercommunication station knobs on radio frequency	9-1005-219-30/2 9-1005-219-30/1 9-1005-219-30/6 9-1005-227-30/7
Motor mount	Gun-laying reticle, auxiliary gunsight reticle, elevation knob lock	Computer shaft boot	Gunner's seat	Stereo light, range-finder spare lamps, stereo control knobs, computer output seal, headrest periscope mount, computer reset light	Super elevation computer, fire-control system	—	Ballistic drive level vial, circuit breaker boot	—	—	Computer, correction knobs	Clean external optics, clean and service T-184 mount, clean reflector elevator quad, ballistic drive linkage		
Ammo storage	—	—	—	Ammo boxes	—	—	Ammo-bracket latch						
Hooks and ramp	—	—	—	Rear deck lifting hook, towing hooks	—	—	Mortar base, holddown bolt, ramp pulley	—	Low ramp pump oil				
Batteries	—	Battery holddown	—	Holddown bolts	—	Battery cables, battery holddown							
Radiators	—	—	—	Radiator cover lock pin, radiator cap	—	—	--	Water pump	Low radiator	—	Clean and flush radiator		
Pump and pulley	—	—	—	—	—	Water-pump belts, fan belt							
Ignition	—	Reseal distributor vent line	Repair magneto	—	—	—	Spark-plug cable						
Carburetion	Primer pump	—	Carburetor	Fuel filters									
Exhaust	—	—	Manifold gasket	—	—	Exhaust pipe bracket	—	Exhausts					
Electrical	Electrical system, turret electrical system	Ready switch, booster motor, rubbing of cable harness by gas tank	Slave receptacle burned	Distributor bell connector	Neutral start switch	Wiring harness, primary lead, generator bell connections, rectifier bell connections	—	—	—	—	—	—	9-2300-203-20/3

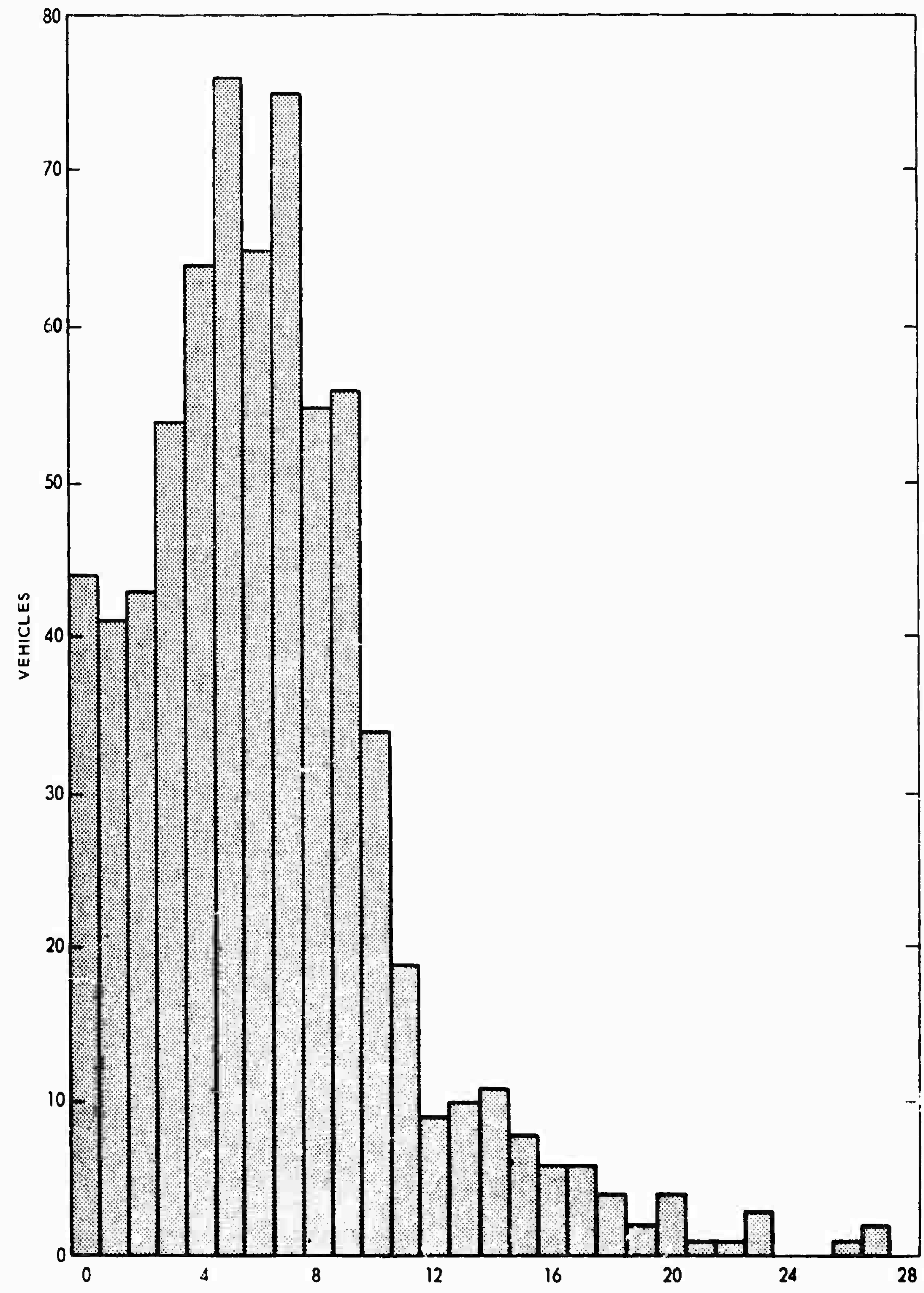


Fig. 1—Distribution of All Deficiencies in 705 ¼-Ton Trucks
M38, M38A1, and M170.

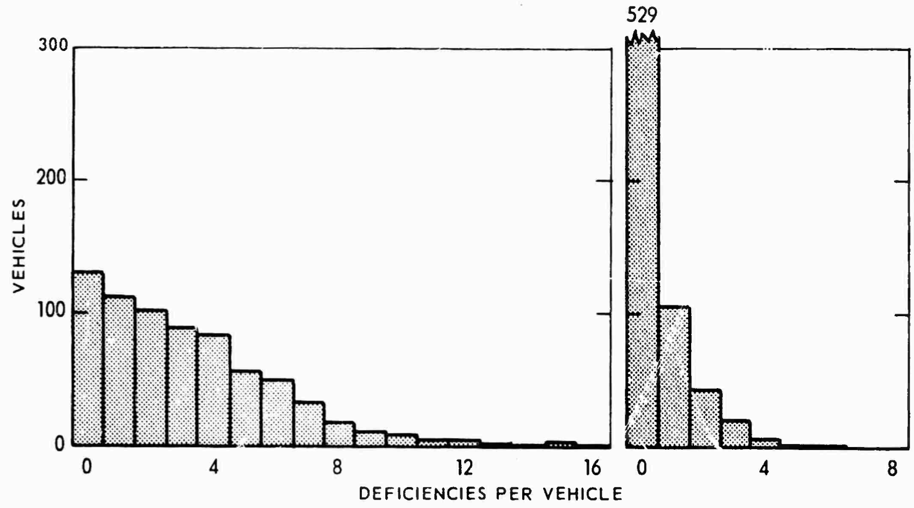


Fig. 2—Distribution of Readiness-Item Deficiencies in 705 ¼-Ton Trucks
M38, M38A1, and M170.

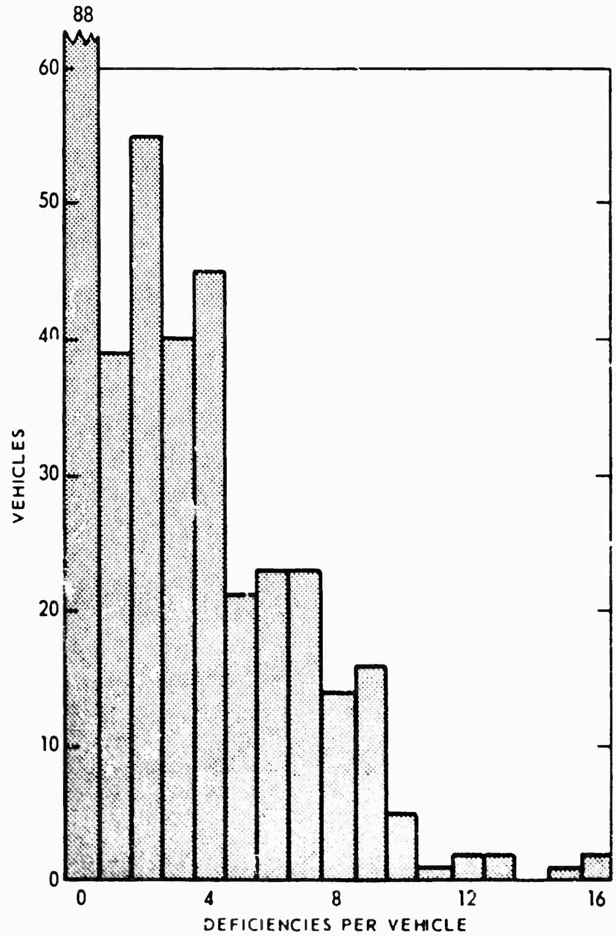
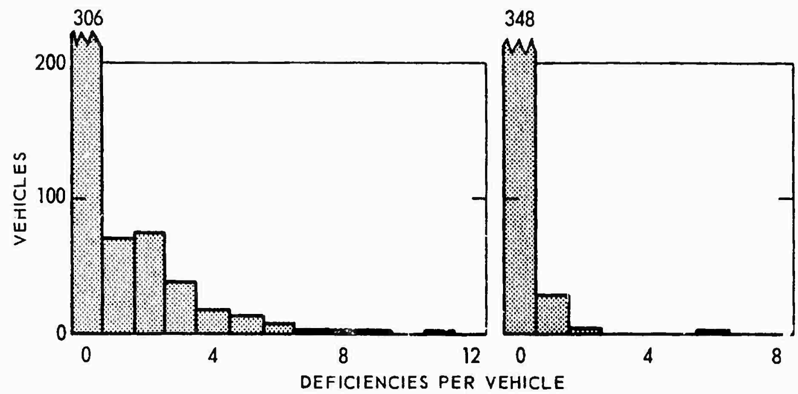


Fig. 3—Distribution of All Deficiencies in 376 ¾-Ton Trucks
M37 and M43.



a. R-O　　　b. R-F

Fig. 4—Distribution of Readiness-Item Deficiencies in 376 ¾-Ton Trucks
M37 and M43.

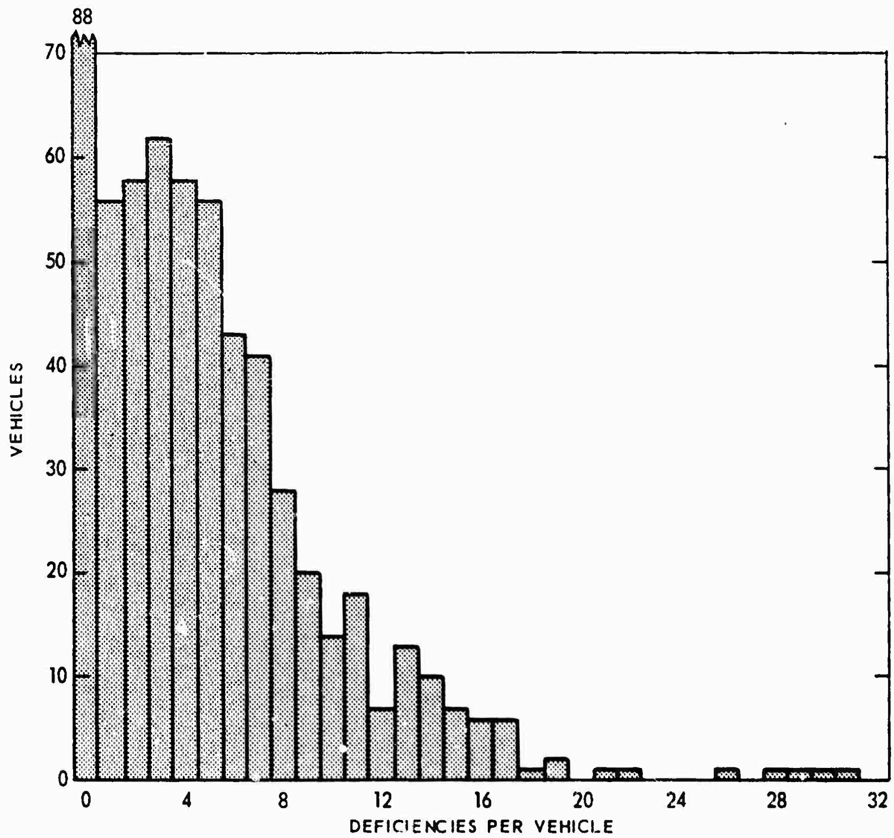


Fig. 5—Distribution of All Deficiencies in 597 2½-Ton Trucks
M34, M35, M49C, M109, and M275.

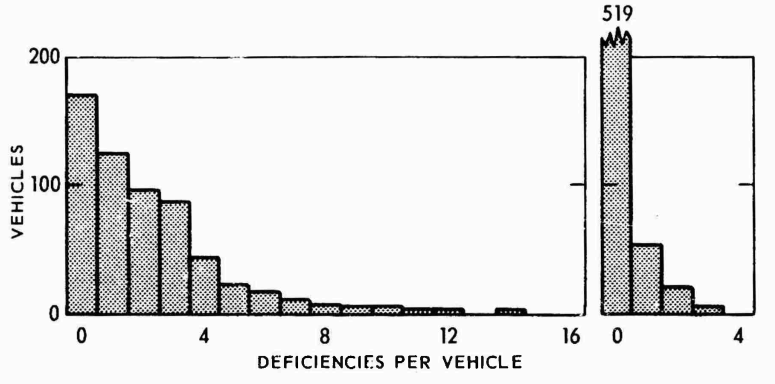


Fig. 6--Distribution of Readiness-Item Deficiencies in 597 2½-Ton Trucks
M34, M35, M49C, M109, and M275.

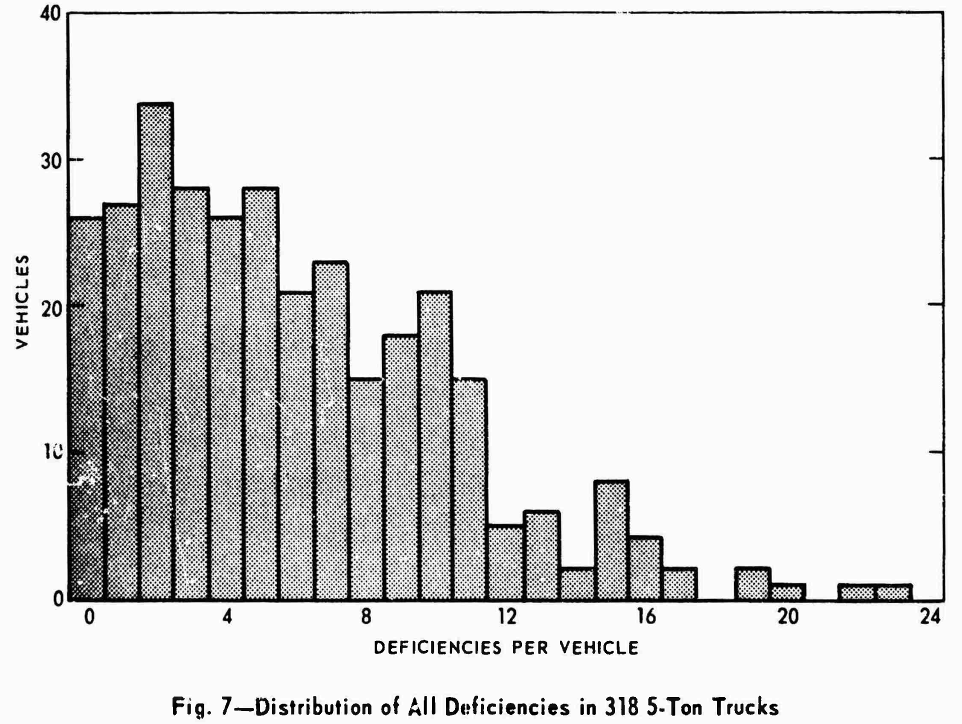


Fig. 7—Distribution of All Deficiencies in 318 5-Ton Trucks
M51, M52, M54, M139, M246, and M543.

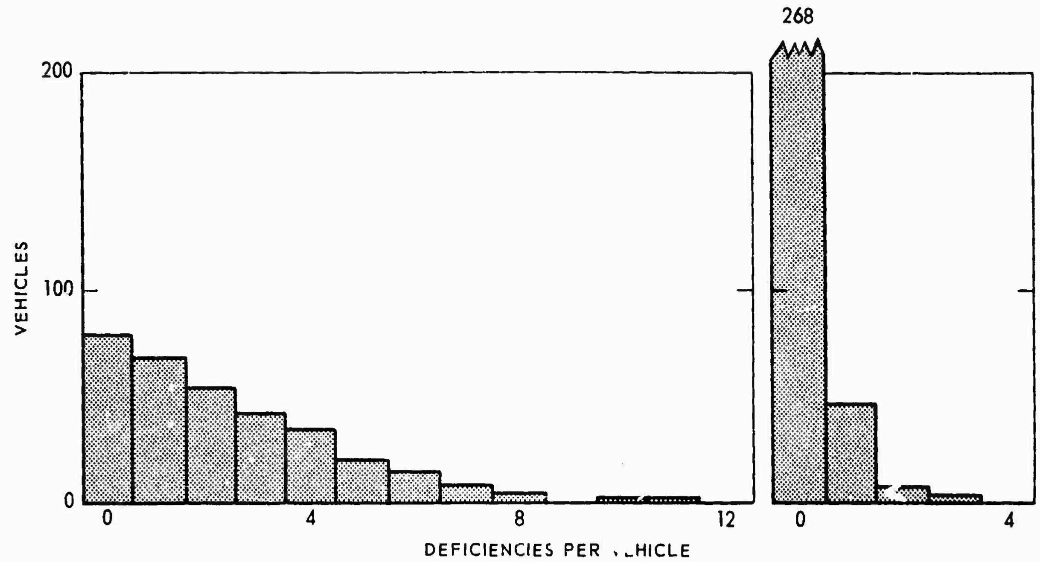


Fig. 8—Distribution of Readiness-Item Deficiencies in 318 5-Ton Trucks

M51, M52, M54, M139, M246, and M543.

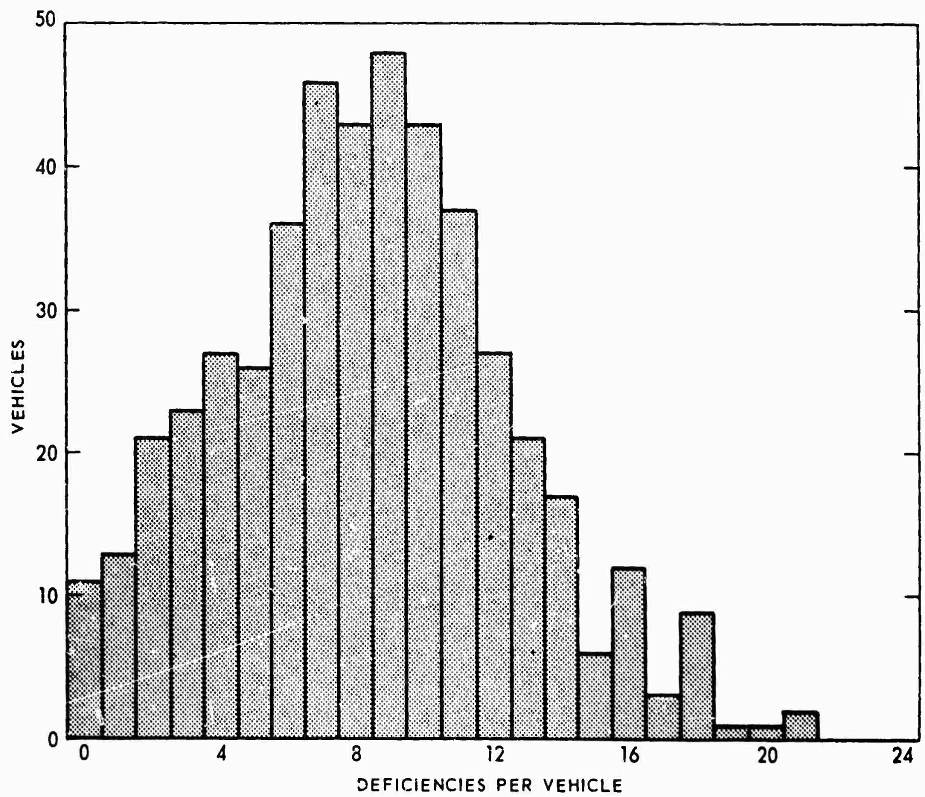


Fig. 9—Distribution of All Deficiencies in 473 APCs

M59 and M84.

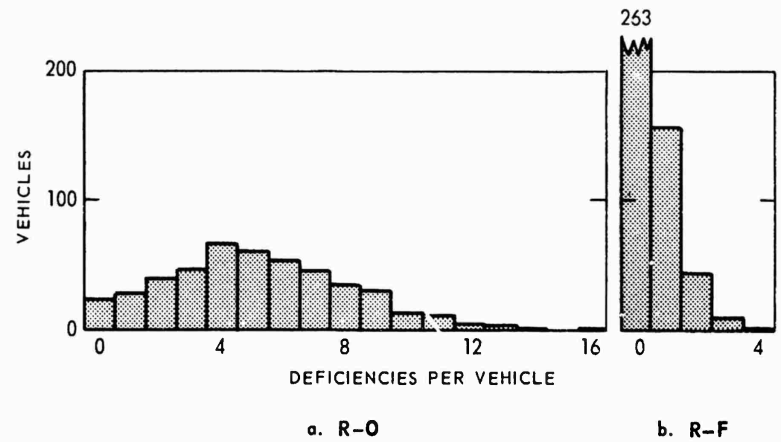


Fig. 10—Distribution of Readiness-Item Deficiencies in 473 APCs

M59 and M84.

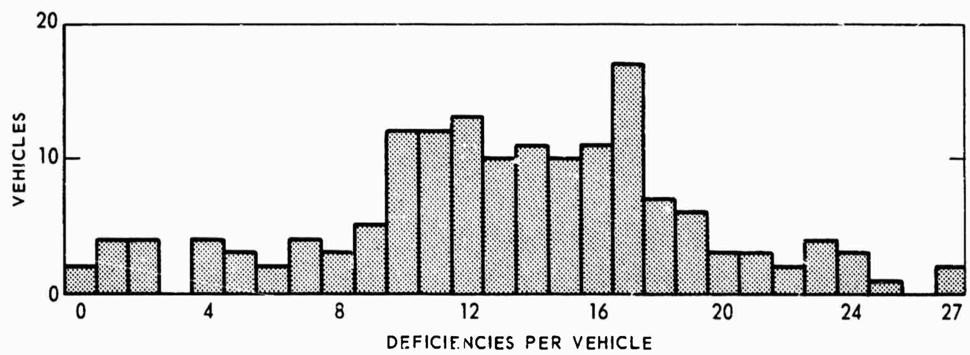


Fig. 11—Distribution of All Deficiencies in 159 Tanks

M48 and M88.

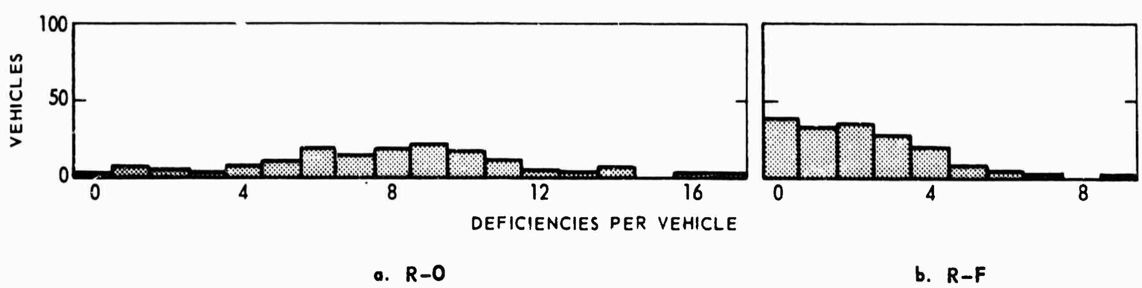


Fig. 12—Distribution of Readiness-Item Deficiencies in 159 Tanks

M48 and M88.

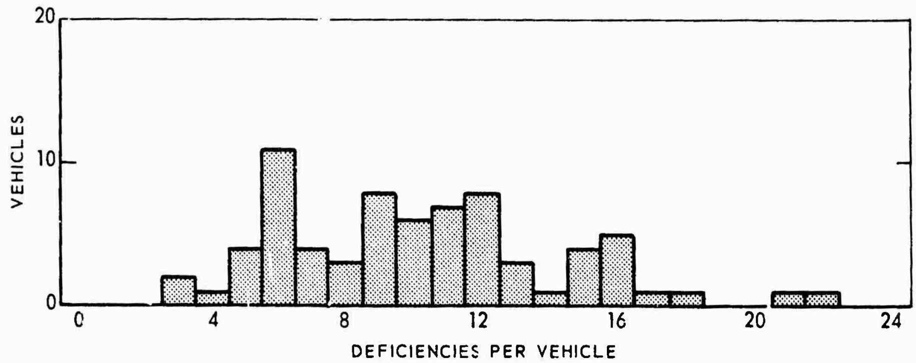
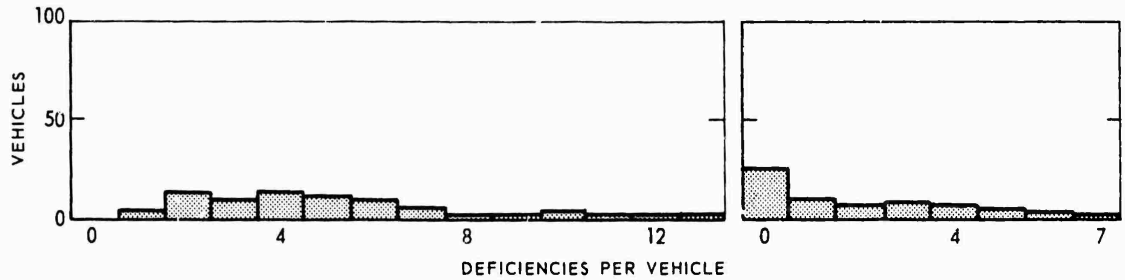


Fig. 13—Distribution of All Deficiencies in 71 SP Artillery Pieces
M44, M52, and M55.



a. R-O   b. R-F

Fig. 14—Distribution of Readiness-Item Deficiencies in 71 SP Artillery Pieces
M44, M52, M55.

TAE

Summary of Deficiencies in P

(O = desirable repair; R-O = readiness-item repair, both at :

a. Numb·r and

Deficiency class	705 ¼-ton[a]								376 ¾-ton[a]							
	O		R-O		R-F		Total		O		R-O		R-F		Total	
	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle
Instruments	56	0.08	53	0.08	0	0	109	0.16	6	0.02	11	0.03	0	0	17	0.05
Accessories	102	0.15	150	0.22	0	0	252	0.37	30	0.08	24	0.06	0	0	54	0.14
Engine	66	0.09	105	0.15	8	0.01	179	0.25	16	0.04	33	0.09	2	0.01	51	0.14
Steering	12	0.02	155	0.22	34	0.05	201	0.29	2	0.01	59	0.16	13	0.04	74	0.21
Clutch	27	0.04	25	0.04	14	0.02	66	0.10	24	0.07	8	0.02	1	—[d]	33	0.09
Brakes	143	0.20	134	0.19	2	—[d]	279	0.39	11	0.03	48	0.13	0	0	59	0.16
Generator, starter	37	0.05	97	0.14	1	—[d]	135	0.19	1	—[d]	32	0.09	0	0	33	0.09
Power train	59	0.08	70	0.10	86	0.12	215	0.30	6	0.02	17	0.05	11	0.03	34	0.10
Noises	16	0.02	15	0.02	3	0.01	34	0.05	5	0.01	8	0.02	0	0	13	0.03
Lamps	71	0.10	192	0.28	0	0	263	0.38	26	0.07	36	0.10	0	0	62	0.17
Suspension, drive	54	0.08	128	0.18	12	0.02	194	0.28	15	0.04	36	0.10	3	0.01	54	0.15
Leaks	5	0.01	40	0.06	18	0.03	63	0.10	1	—[d]	8	0.02	1	—[d]	10	0.02
Lubrication, tires	44	0.06	71	0.10	0	0	115	0.16	11	0.03	32	0.09	1	—[d]	44	0.12
Battery	40	0.06	112	0.16	0	0	152	0.22	14	0.05	11	0.04	0	0	25	0.09
Crankcase	51	0.07	6	0.01	0	0	57	0.08	8	0.02	1	—[d]	0	0	9	0.02
Radiator	42	0.06	37	0.05	0	0	79	0.11	17	0.05	13	0.04	0	0	30	0.09
Pumps, belts, pulleys	34	0.05	13	0.02	0	0	47	0.07	36	0.10	13	0.04	0	0	49	0.14
Ignition	27	0.04	44	0.06	0	0	71	0.10	13	0.04	25	0.07	0	0	38	0.11
Carburetor	30	0.04	50	0.07	0	0	80	0.11	7	0.02	15	0.04	5	0.01	27	0.07
Exhaust system	31	0.04	26	0.05	1	—[d]	58	0.09	27	0.08	4	0.02	0	0	31	0.10
Wheels	6	0.01	62	0.09	0	0	68	0.10	1	—[d]	23	0.06	0	0	24	0.06
Hardware, canvas, body	958	1.36	618	0.88	97	0.14	1673	2.38	368	0.98	108	0.29	1	—[d]	477	1.27
Other	3	—[d]	14	0.02	0	0	17	0.02	9	0.02	9	0.02	0	0	18	0.04
Total indicated repair actions	1914	2.71	2217	3.14	276	0.39	4407	6.24	654	1.74	574	1.53	38	0.10	1266	3.37

b. Recorded Repair A

Disposition	383 ¼-ton	45 ¾-t
R-O[a]	82	61
R-F[a]	30	9
Third-echelon shop[c]	34.7	11.7
No deficiencies found[a]	6.3	23.4

[a]From TI Forms 2404.
[b]Included for insert only; sample considered too smal
[c]From Ordnance work orders.
[d]Negligible.

TABLE 5

:ies in Prepositioned Wheeled Vehicles

r, both at second echelon; R-F = readiness-item repair at third echelon)

ımber and Size of Vehicles

	597 2½-ton[a]								318 5-ton[a]								5 10-ton[b]			
Total	O		R-O		R-F		Total		O		R-O		R-F		Total		O	R-O	R-F	Total
Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number	Average per vehicle	Number			
0.05	15	0.03	55	0.09	0	0	70	0.12	18	0.06	71	0.22	0	0	89	0.28	1	0	0	1
0.14	128	0.21	39	0.07	0	0	167	0.28	95	0.30	32	0.10	0	0	127	0.40	2	0	0	2
0.14	35	0.06	90	0.15	15	0.03	140	0.24	21	0.07	23	0.07	2	0.01	46	0.15	0	0	0	0
0.21	11	0.02	77	0.13	3	0.01	91	0.16	16	0.05	112	0.35	26	0.09	154	0.49	1	0	0	1
0.09	20	0.03	25	0.04	2	—[d]	47	0.07	8	0.03	13	0.04	3	0.01	24	0.08	0	0	0	0
0.16	57	0.10	195	0.33	0	0	252	0.43	49	0.15	94	0.30	0	0	143	0.45	0	0	0	0
0.09	19	0.03	20	0.03	1	—[d]	40	0.06	20	0.07	6	0.02	0	0	26	0.09	1	0	0	1
0.10	9	0.02	42	0.07	32	0.05	83	0.14	11	0.04	12	0.04	7	0.02	30	0.13	0	0	0	0
0.03	5	0.01	14	0.02	2	—[d]	21	0.03	0	0	0	0	0	0	0	0	0	0	0	0
0.17	56	0.09	33	0.06	0	0	89	0.15	58	0.19	44	0.14	0	0	102	0.33	1	3	0	4
0.15	35	0.06	215	0.36	24	0.04	274	0.46	18	0.06	93	0.29	11	0.04	122	0.39	1	0	1	2
0.02	2	—[d]	65	0.11	12	0.02	79	0.13	5	0.02	13	0.04	10	0.03	28	0.09	0	1	0	1
0.12	25	0.04	67	0.11	0	0	92	0.15	11	0.04	88	0.28	1	—[d]	100	0.32	0	0	0	0
0.09	30	0.05	11	0.02	0	0	41	0.07	19	0.06	6	0.02	0	0	25	0.08	0	0	0	0
0.02	132	0.22	6	0.01	0	0	138	0.23	70	0.22	1	—[d]	0	0	71	0.22	2	0	0	2
0.09	105	0.18	38	0.06	2	—[d]	145	0.24	33	0.10	10	0.03	1	[d]	44	0.13	0	1	0	1
0.14	68	0.11	12	0.02	0	0	80	0.13	49	0.15	3	0.01	0	0	52	0.16	0	0	0	0
0.11	1	—[d]	56	0.09	0	0	57	0.09	1	—[d]	25	0.08	0	0	26	0.08	0	2	0	2
0.07	30	0.05	38	0.06	8	0.01	76	0.12	40	0.13	11	0.03	0	0	51	0.16	2	0	0	2
0.10	53	0.09	8	0.03	0	0	61	1.03	30	0.10	1	—[d]	0	0	31	0.10	4	0	0	4
0.06	2	—[d]	12	0.02	0	0	14	0.02	4	0.01	2	0.01	1	—[d]	7	0.02	0	0	0	0
1.27	740	1.23	30	0.05	11	0.02	781	1.30	444	1.40	8	0.03	2	0.01	454	1.44	5	0	0	5
0.04	69	0.12	90	0.15	0	0	159	0.27	83	0.27	63	0.10	2	0.01	148	0.38	1	1	0	2
3.37	1647	2.76	1238	2.07	112	0.19	2997	5.02	1103	3.47	731	2.30	66	0.21	1900	5.98	21	8	1	30

epair Actions, Third Echelon

Number and size of vehicle			
45 ¾-ton	207 2½-ton	113 5-ton	7 10-ton
Vehicles, %			
61	72	76	—
9	13	16	—
11.7	19.1	25.8	—
23.4	10.2	8.2	3

o small for significance.

TABLE 6

Numbers of Deficiencies in Prepositioned Tracked Vehicles

(O = desirable repair; R-O = readiness-item repair, both at second echelon; R-F = readiness-item repair at third echelon)

a. Number and Size of Vehicles

Deficiency class	473 APCs, O, No.	O, Average per vehicle	R-O, No.	R-O, Average per vehicle	R-F, No.	R-F, Average per vehicle	Total, No.	Total, Average per vehicle
Instruments	12	0.03	44	0.09	1	Neg	57	0.12
Horn	0	0	15	0.03	0	0	15	0.03
Lamps	36	0.08	155	0.33	16	0.03	207	0.44
Engine	202	0.43	713	1.51	154	0.33	1069	2.27
Suspension	40	0.08	45	0.10	0	0	85	0.18
Brakes	2	0.01	86	0.18	0	0	88	0.19
Power train	178	0.38	426	0.91	17	0.04	621	1.33
Noises	0	0	21	0.04	0	0	21	0.04
Leaks	3	0.01	10	0.02	0	0	13	0.03
Openings, plugs	363	0.77	171	0.36	31	0.07	565	1.20
Hooks, ramp	40	0.08	23	0.05	1	Neg	64	0.13
Lubricate	9	0.02	31	0.07	0	0	40	0.09
Battery	4	0.01	40	0.08	0	0	44	0.09
Radiator	61	0.14	177	0.37	1	Neg	239	0.51
Pumps, pulleys	3	0.01	49	0.10	0	0	52	0.11
Ignition	0	0	16	0.03	0	0	16	0.03
Valves	0	0	11	0.02	0	0	11	0.02
Carburetion	6	0.01	87	0.18	4	0.01	97	0.20
Exhaust	18	0.04	86	0.18	0	0	104	0.22
Manifold	1	Neg	34	0.07	0	0	35	0.07
Cooling fans	0	0	1	Neg	0	0	1	Neg
Electrical	7	0.02	204	0.44	12	0.03	223	0.49
Oil cooler	6	0.01	4	0.01	0	0	10	0.02
Transmission band	4	0.01	0	0	0	0	4	0.01
Other[a]	22	0.15	83	0.17	46	0.10	201	0.42
Total indicated repair actions	1067	2.26	2532	5.35	283	0.60	3882	8.21

Deficiency class	159 tanks, O, No.	O, Average per vehicle	R-O, No.	R-O, Average per vehicle	R-F, No.	R-F, Average per vehicle	Total, No.	Total, Average per vehicle
Instruments	1	0.01	36	0.23	0	0	37	0.24
Horn	0	0	2	0.01	0	0	2	0.01
Lamps	25	0.16	108	0.68	0	0	133	0.84
Engine	48	0.40	122	0.77	0	0	170	1.17
Suspension	11	0.07	72	0.45	0	0	83	0.52
Brakes	4	0.03	14	0.09	0	0	18	0.12
Power train	23	0.15	23	0.15	1	0.01	47	0.31
Noises	0	0	0	0	0	0	0	0
Leaks	0	0	1	0.01	0	0	1	0.01
Openings, plugs	248	1.56	70	0.44	17	1.35	335	3.35
Hooks, ramp	2	0.01	0	0	0	0	2	0.01
Lubricate	0	0	4	0.03	0	0	4	0.03
Battery	0	0	26	0.17	0	0	26	0.17
Radiator	0	0	0	0	0	0	0	0
Pumps, pulleys	0	0	0	0	0	0	0	0
Ignition	0	0	8	0.05	0	0	8	0.05
Valves	0	0	0	0	0	0	0	0
Carburetion	2	0.01	14	0.09	0	0	16	0.10
Exhaust	1	0.01	0	0	0	0	1	0.01
Manifold	0	0	0	0	0	0	0	0
Cooling fans	0	0	1	0.01	0	0	1	0.01
Electrical	2	0.01	54	0.34	0	0	56	0.35
Oil cooler	0	0	0	0	0	0	0	0
Transmission band	0	0	0	0	0	0	0	0
Other[a]	238	1.49	608	3.82	317	1.99	1163	7.30
Total indicated repair actions	605	3.81	1163	7.31	335	2.11	2103	13.23

Deficiency class	71 SP howitzers, O, No.	O, Average per vehicle	R-O, No.	R-O, Average per vehicle	R-F, No.	R-F, Average per vehicle	Total, No.	Total, Average per vehicle
Instruments	2	0.03	15	0.22	0	0	17	0.25
Horn	0	0	6	0.09	0	0	6	0.09
Lamps	7	0.10	38	0.54	0	0	45	0.64
Engine	14	0.20	26	0.37	2	0.03	42	0.60
Suspension	3	0.04	9	0.13	0	0	12	0.17
Brakes	1	0.02	9	0.13	0	0	10	0.15
Power train	4	0.06	19	0.27	2	0.03	25	0.36
Noises	0	0	8	0.12	0	0	8	0.12
Leaks	0	0	15	0.22	0	0	15	0.22
Openings, plugs	173	2.44	58	0.83	5	0.07	236	3.34
Hooks, ramp	4	0.06	1	0.02	0	0	5	0.08
Lubricate	0	0	0	0	0	0	0	0
Battery	1	0.02	22	0.32	0	0	23	0.34
Radiator	0	0	0	0	0	0	0	0
Pumps, pulleys	0	0	0	0	0	0	0	0
Ignition	0	0	0	0	0	0	0	0
Valves	0	0	0	0	0	0	0	0
Carburetion	0	0	0	0	0	0	0	0
Exhaust	0	0	1	0.02	0	0	1	0.02
Manifold	0	0	0	0	0	0	0	0
Cooling fans	0	0	0	0	0	0	0	0
Electrical	2	0.03	12	0.17	1	0.02	15	0.22
Oil cooler	0	0	0	0	0	0	0	0
Transmission band	0	0	0	0	0	0	0	0
Other[a]	12	–	98	–	157	–	267	–
Total indicated repair actions	223	3.14	337	4.75	167	2.35	727	10.24

b. Recorded Repair Actions, Third Echelon[b]

Disposition	Number and size of vehicle: 143 APCs	26 tanks	SP howitzers[c]
	Vehicles, %		
R-O[d]	95	97	100
R-F[d]	44	77	65
Third-echelon shop[b]	23.3	17	na
No deficiencies found[d]	2.8	3.8	0

[a] Nonautomotive items: cupola, turret; auxiliary engine; mortar mount; ammo storage.
[b] Ordnance work orders; repairs on items listed in footnote a excluded.
[c] Total not available.
[d] TI Forms 2404.

TABLE 7

Preexercise Third-Echelon Report on Vehicles by Type—TI Sample, 2d Armd Div

a. Repair Actions

Action category	¼-ton truck Number	¼-ton truck Average m-hr per vehicle	¾-ton truck Number	¾-ton truck Average m-hr per vehicle	2½-ton truck Number	2½-ton truck Average m-hr per vehicle	5-ton truck Number	5-ton truck Average m-hr per vehicle	10-ton truck Number	10-ton truck Average m-hr per vehicle	APC Number	APC Average m-hr per vehicle	Tank Number	Tank Average m-hr per vehicle	SP howitzer Number	SP howitzer Average m-hr per vehicle
Replacement																
Engine	34	8	2	9	24	15	6	15	2	26	24	15	13	31	—	—
Transmission	21	6	1	4	4	9	2	7	1	6	43	14	7	21	—	—
Transfer case	10	6	2	5	3	11	1	6	1	6	—	—	—	—	—	—
Axle	8	4	—	—	4	4	—	—	—	—	—	—	—	—	—	—
Differential	1	3	—	—	5	6	—	—	—	—	11	11	—	—	—	—
Steering	27	4	5	5	2	6	17	9	—	—	—	—	—	—	—	—
Clutch	1	10	—	—	1	12	—	—	—	—	—	—	—	—	—	—
Oil pump	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—
Power takeoff	—	—	—	—	1	15	4	5	—	—	—	—	—	—	—	—
Governor	—	—	—	—	—	—	—	—	—	—	2	4	—	—	—	—
Final drive	—	—	—	—	—	—	—	—	—	—	5	3	—	—	—	—
Hydraulic pump	—	—	—	—	—	—	1	4	—	—	2	6	—	—	—	—
Seal																
Transfer	86	3	9	2	34	3	3	3	2	6	—	—	—	—	—	—
Transmission	39	3	3	2	20	4	[illegible]	5	—	—	—	—	1	3	—	—
Axle	25	3	5	4	51	3	19	3	—	—	—	—	—	—	—	—
Shifter shaft	15	2	1	1	15	3	6	2	—	—	—	—	—	—	—	—
Steering	2	1	2	3	—	—	7	2	—	—	—	—	—	—	—	—
Power takeoff	—	—	—	—	—	—	[illegible]	2	—	—	—	—	—	—	—	—
Differential	—	—	—	—	—	—	2	3	—	—	—	—	—	—	—	—
Repairs																
Engine	5	3	1	5	8	7	3	5	—	—	9	10	3	7	—	—
Transmission	2	7	—	—	1	17	—	—	—	—	18	3	—	—	—	—
Transfer case	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Differential	—	—	—	—	1	14	—	—	—	—	2	2	—	—	—	—
Steering	13	2	1	2	2	1	9	4	—	—	—	—	—	—	—	—
Clutch	39	4	—	—	14	4	3	11	1	3	—	—	—	—	—	—
Governor	—	—	—	—	1	4	3	2	—	—	17	2	—	—	—	—
Body	35	3	1	3	6	4	3	2	—	—	—	—	—	—	—	—
Miscellaneous	6	3	1	5	10	3	8	7	—	—	6	2	2	3	—	—
MWO	13	7	11	8	—	—	—	—	—	—	4	47	—	—	—	—
Washout	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—

b. Summary

Category	Type of vehicle: ¼-ton truck	¾-ton truck	2½-ton truck	5-ton truck	10-ton truck	APC	Tank	Totals: All wheeled[b]	Totals: tracked[a]
Number of vehicles sampled	705	375	597	318	5	473	159	2001	632
Sample vehicles to shop[c]	244	44	114	82	3	110	27	467	137
Percent	34.7	11.7	19.1	25.8	60.0	23.3	17.0	25.0	20.0
Number of repair actions sampled[c]	383	45	207	113	7	143	36	755	169
Seal	167	20	120	52	2	0	1	361	1
Replacements	102	10	44	32	4	87	30	192	107
Total vehicles in each class[d]	1192	731	1057	488	25	609	421	3493	1030
Percent sampled	59.1	51.4	56.5	65.3	20.0	77.8	37.8	57.5	61.5

[a]Excluding SP howitzer; information not available.
[b]Excluding trailers.
[c]Ordnance work orders.
[d]Including float.

prior to the march to the assembly area and second, by the number of vehicles not starting. Logs of the OCC showed 23 repairs in the staging area and observers on the ground from the Army Materiel Board reported 78. Several were reported at Chenevières, but the exact number was not obtainable. In the sample units, 6 vehicles from Germersheim and 11 vehicles in Kaiserslautern failed to meet the operational-readiness criterion. From all this information it was estimated that operational readiness was higher than 98 percent in 2d Armd Div, at least comparable to 3d Armd Div and therefore satisfactory. The data were not sufficient to make a more accurate estimate.

TABLE 8

Reported Average Third-Echelon Repair Times in 3d Armd Div and 2d Armd Div

Vehicle type	3d Armd Div, m-hr	2d Armd Div, m-hr
Trucks		
¼-ton	6.1 (M151)	6.6 (M38)
¾-ton	7.3	6.0
2½-ton	6.7 (M35)	9.7 (M34, M35)
5-ton	9.4	7.1
10-ton	30.7	27.8
APC	10.8 (M113)	10.5 (M59)
Tanks	9.8 (M60)	29.4 (M48)
SP artillery	9.1	na

Estimate of Significant Preexercise Repairs

Table 7 gives the significant third-echelon repairs and replacements in a sample of 2704 prepositioned vehicles restationed at Pirmasens and Kaiserslautern, as derived from the work-order forms of the supporting ordnance companies. The records of the service units in each ordnance company were not examined, so repairs to canvas, glass, and some body repairs are not complete. By extrapolating from the sample, using the reciprocal of the percentage of each vehicle type in the sample, an estimate of the direct repairs can be made (see Table 9). Repairs reported by the 2d Armd Div maintenance battalion in the staging area are also included.

Repairs and replacements in the 3d Armd Div for the same period were obtained from the sample units and extrapolated for the division. Since the 3d Armd Div sample was smaller, the extrapolation has a lower degree of accuracy than the 2d Armd Div data; however, the values obtained are offered for general comparison. Note that the 3d Armd Div values are for the division only. In 2d Armd Div, two values are given: the first for the number of vehicles actually involved (2d Armd Div augmented) and the second, in parentheses, for the same number of vehicles on which the 3d Armd Div values are based. The second set offers a more direct comparison with 3d Armd Div.

The Ordnance after-action report [19] generally gives higher numbers of major assemblies issued for wheeled vehicles than the estimates contained in Table 9. The sequential numbering of the work orders and a matching of registration numbers provide firm support for the belief that the records of

TABLE 9

Estimated Preexercise Direct Repairs and Replacements of Selected Vehicles, 2d Armd Div Augmented and 3d Armd Div

(Values for 3d Armd Div, division only; division-only values, i.e., same number of vehicles, for 2d Armd Div provided, in parentheses, for comparison)

Type or class	Type of vehicle													
	¼-ton truck		¾-ton truck		2½-ton truck		5-ton truck		APC		Tank		SP howitzer	
	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div
Replacement														
Engine	59 (47)	44	4 (3)	16	43(36)	45	9 (9)	7	31(33)	37	35(39)	12	0	25
Transmission	36 (29)	48	2 (2)	16	7 (6)	4	3 (3)	20	56(60)	17	19(21)	22	0	25
Transfer case	17 (14)	4	4 (3)	24	6 (5)	14	2 (–)	3	0	3	0	0	0	0
Axle	14 (11)	4	0	0	7 (6)	7	0	3	–	–	–	–	–	–
Differential	2 (2)	20	0	8	9 (8)	7	0	0	14(15)	0	–	–	–	–
Steering	46 (38)	4	10 (8)	8	4 (3)	4	26(24)	10	0	0	0	3	0	0
Clutch	3 (3)	0	0	0	3 (3)	0	3 (3)	0	0	0	0	0	0	0
Final drive	–	–	–	–	–	–	–	–	6 (7)	3	0	0	0	0
Seal replacement														
Transfer	145(119)	–	18(15)	–	60(50)	–	5 (5)	–	0	–	0	–	0	–
Transmission	67 (54)	–	6 (5)	–	36(30)	–	8 (8)	–	0	–	3 (3)	–	0	–
Axle	43 (35)	–	10 (8)	–	90(75)	–	29(27)	–	0	–	0	–	0	–
Shifter shaft	26 (21)	–	2 (2)	–	27(22)	–	9 (9)	–	0	–	0	–	0	–
Steering	4 (3)	–	4 (3)	–	0	–	11(10)	–	0	–	0	–	0	–
Other	0	–	0	–	0	–	19(17)	–	0	–	0	–	0	–
Repairs														
Engine	9 (7)	4	2 (2)	0	14(12)	4	5 (5)	3	12(13)	0	8 (9)	7	0	0
Transmission	4 (3)	0	0	0	2 (2)	0	0	0	23(25)	0	0	3	0	0
Transfer	2 (2)	0	0	0	0	0	0	0	0	0	0	0	0	0
Differential and final drive	0	0	0	0	2 (2)	0	0	0	3 (3)	0	0	0	0	0
Steering	22 (18)	0	2 (2)	0	4 (3)	0	14(13)	7	0	0	0	0	0	0
Clutch	66 (54)	0	0	0	25(21)	0	5 (5)	3	0	0	0	0	0	0
Governor	–	–	–	–	2 (2)	–	5 (5)	–	22(24)	–	–	–	–	–
Body	60 (49)	–	2 (2)	–	11 (9)	–	5 (5)	–	–	–	–	–	–	–
Multipliers[a]														
For total estimate (reciprocal of percent in sample)	1.69	4.0	1.95	8.0	1.77	3.2	1.53	3.2	1.29	4.2	2.65	4.0	1.57	5.0
For division-only estimate (for direct comparison)	1.38	–	1.59	–	1.47	–	1.39	–	1.38	–	3.0	–	1.07	–

[a]Multipliers for the 3d Armd Div reflect the actual coverage rather than the planned coverage of the original sample; 2d Armd Div multipliers are from the Ordnance work orders obtained after BIG LIFT.

the 2704-vehicle sample are complete. It is difficult to explain the discrepancy except on the grounds that possibly a number of wheeled-vehicle repairs were made by contact teams and not recorded as work orders. On the other hand, the numbers of replacement major assemblies for tracked vehicles agree quite closely with the estimate in Table 9.

In the absence of more up-to-date information, it is suggested that both sources be used to establish upper and lower bounds for the range of repair parts required by prepositioned equipment of an armored division to prepare to take the field when the equipment is not maintained RFI. The preparatory requirements of the infantry division can be interpolated from the data furnished.

AIRLIFT PHASE

In the airlift phase no examination was conducted of (a) the Air Force and of Military Air Transport Service participation, except where there was an impact on the support functions of Seventh Army, or of (b) CONUS activities. Data generated by the airlift were collected by a RACFOE team stationed at the MCC.

For the main body of the division the total elapsed time for the deployment was 63 hr 5 min, from first takeoff in CONUS to the last arrival in Europe.[9] The interval between first and last arrivals in Europe was 52 hr 15 min, during which time 210 aircraft (acft) delivered 14,221 passengers (pax) with associated cargo, or an average of 68 pax per acft. The advance party of 502 troops arrived 20 October, 2 days before the main body, in 7 C-135 acft. Aircraft sorties are shown in Table 10.

TABLE 10

Aircraft Sorties and Number of Troop Passengers

Aircraft	Number of sorties	Passengers	Average passengers
C-118	29	1,511	52
C-124	98	7,626	78
C-130	31	1,733	56
C-133[a]	5	40	8
C-135	54	3,813	71[b]
Total	217	14,723	68

[a]Baggage.
[b]Includes advance party.

The two major aspects of the airlift of importance to the prepositioning concept are discussed in the following sections.

Transportation Support Required To Service Arrival Rate of Aircraft at Airbase

A total of 6 light truck companies, representing 43 percent of the light truck companies in Seventh Army, and 3 medium truck companies were assigned to the task of moving the troops from the air base to the staging areas. There were 12 sortie diversions to alternative destinations (see Table 11), but the transportation capacity was never severely taxed even had there been no diversions.

TABLE 11

Sortie Diversions

Aircraft	Destination	Landed	Reason	Troops
C-124	Ramstein	Rhein/Main	Unknown	76
C-124	Toul-Rosières	Chambley	↕	70
C-124	↕	Chambley	↕	68
C-124	↕	Chambley	↕	68
C-124	↕	Chateauroux	↕	67
C-124	↕	Mildenhall	↕	68
C-124	Toul-Rosieres	Mildenhall	Unknown	69
C-135	Rhein/Main	Ramstein	Fog	75
C-135	↕	Ramstein	Fog	73
C-135	↕	London	Plane trouble	72
C-135	↕	Ramstein	Fog	74
C-135	Rhein/Main	Ramstein	Fog	68
Total				848

The Seventh Army Transportation Officer, reporting in the Seventh Army after-action report,[14] states that the movement could have been accomplished marginally by three light truck companies—approximately 180 vehicles. To check this statement, a time schedule of immediate vehicle availability was plotted against troop readiness for departure (see Fig. 15) in an arbitrary ordering without any attempt at an optimum allocation. This plot showed that 176 vehicles—approximately 3 light truck companies—would have been adequate for the lift by working 4 to 5 10-hr shifts around the clock. However, both planes and trucks would have had to adhere to precise schedules. Though it is recognized that diversions could have been considerably higher, it is concluded for planning purposes that 4 light truck companies would have been safely adequate for the ground movement of the division from the air bases to staging, or marry-up, areas used in BIG LIFT.

If the airlift were spread over a longer period—a possible outcome of a surprise alert—fewer vehicles would be required.

Troop Concentrations at Air Base and Staging Area

The average troop delay at the air base was 1 hr 29 min, which included debarkation, orientation, meal time, entrucking, and time to starting point. The first march unit departed the air base 2 hr after arrival of the first aircraft. The overall transport time, i.e., the last arrival at a staging area after the first departure from the air base, was 54 hr 50 min. The approximate distribution of troops and the average time en route are shown in Table 12.

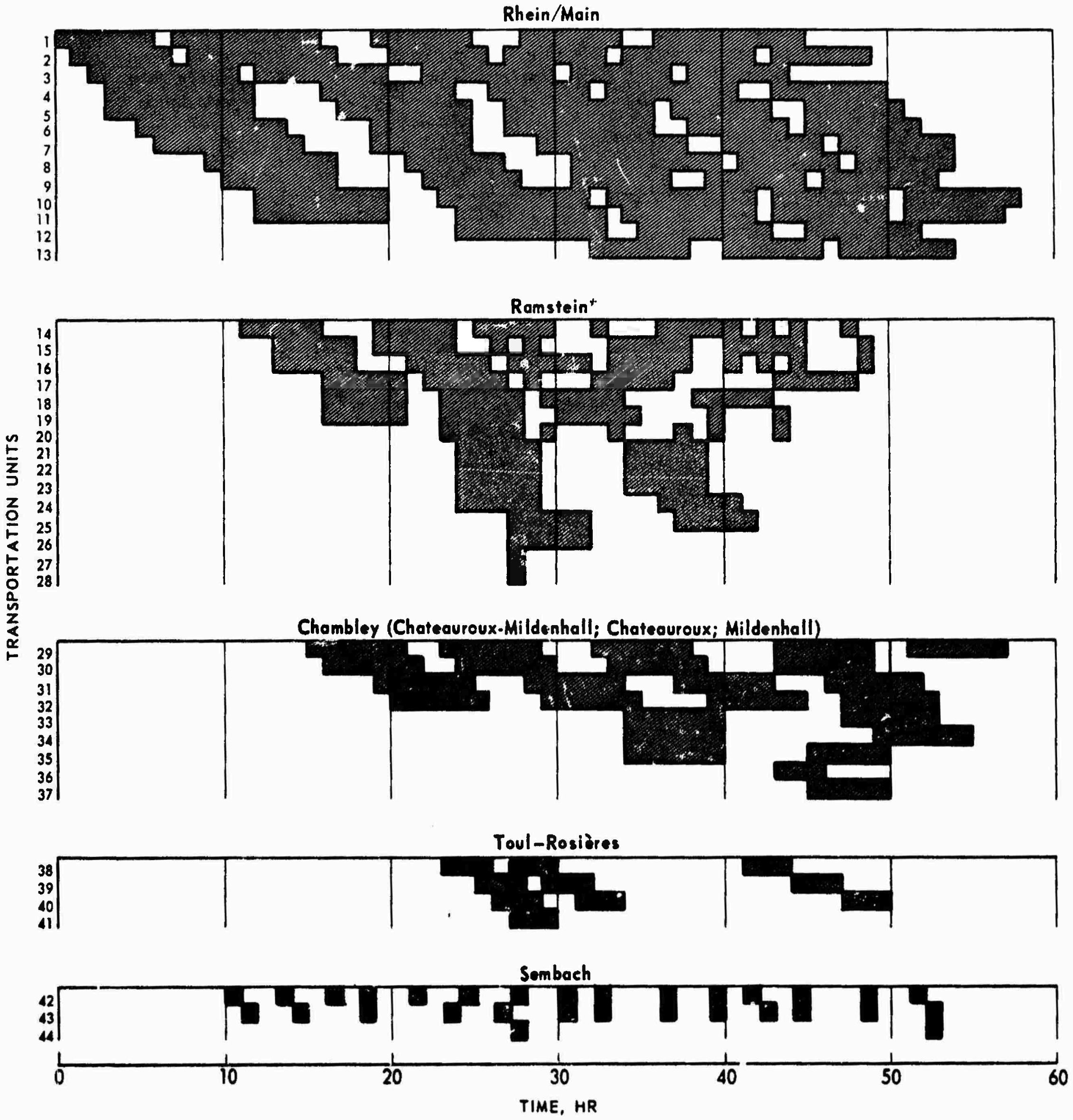


Fig. 15—Arbitrary Plot of Vehicle Availability and Scheduled Troop Departures

Each transportation unit represents sufficient transportation to move one plane load of troops with baggage—about four vehicles.

*Vehicles can be diverted to Rhein/Main to relieve any excess demand.

TABLE 12

Time En Route from Air Base to Staging Area, Main Body of Troops[a] and Advance Party

Air base	Staging area	Distance, km	Average driving time for shuttle		Main-body troops moved	Approximate population	
			Hours	Minutes		Advance party	Staging area
Ramstein	Lorsch	105	2	26	491	31	522
Ramstein	Pirmasens	74	2	15	1,866	–	–
Rhein/Main	Pirmasens	216	4	24	1,270	32	3,168
Ramstein	K1 Spesbach	2	0	31	1,712	–	–
Sembach	K1 Spesbach	26	0	40	1,599	–	–
Rhein/Main	K1 Spesbach	161	3	0	2,284	297	5,892
Ramstein	K2 Cold Storage Area	16	0	50	256	–	–
Rhein/Main	K2 Cold Storage Area	141	4	0	470	14	740
Sembach	K3 General Depot	5	0	43	78	–	–
Rhein/Main	K3 General Depot	136	3	3	323	–	–
Ramstein	K3 General Depot	21	0	15	34	11	446
Chambley	Chenevières	–	3	6	1,227	–	–
Toul-Rosières	Chenevières	–	1	38	694	–	–
Chateauroux	Chenevières	–	1	40	67	–	–
Toul-Rosières via Mildenhall	Chenevières	–	2	40	137	90	2,215
Rhein/Main	Germersheim	138	3	35	1,713	27	1,740
Total					14,221	502	14,723

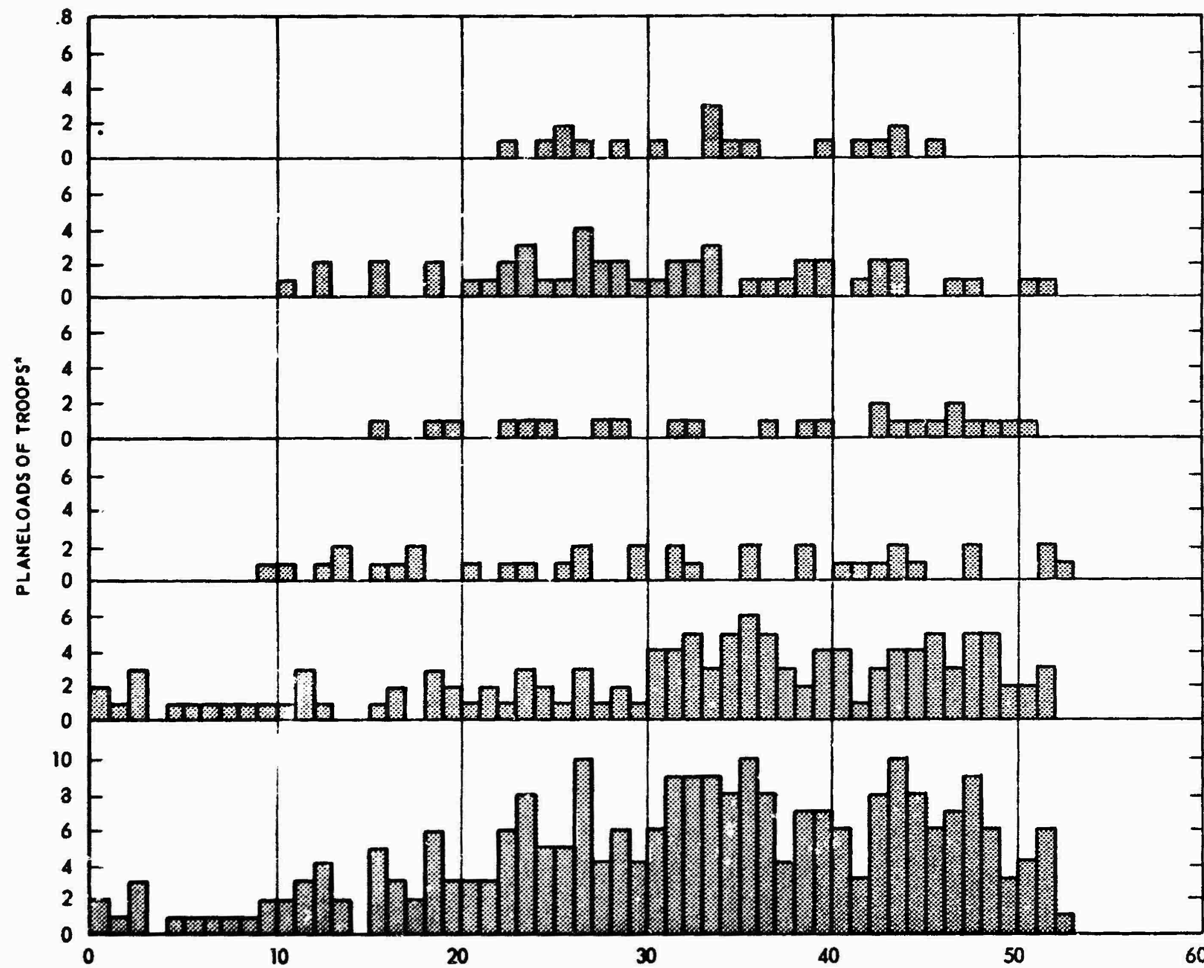
[a]Reported by MCC.

The concentration of troops at each of the five major air bases is contrasted with theoretical concentration at a single composite air base in Fig. 16. The accumulation at any point in time was not large, even for a composite hypothetical air base. Longer intervals between sorties would have decreased the concentration even more, and the converse is also true. Vulnerability of the troops to possible hostile action reached a maximum between 30 and 50 hr after the landing of the first aircraft.

If the profitability of the air base itself as a target is neglected and later concentrations at the staging areas are taken into account, the airlift phase does not present the most lucrative set of targets if deployment is attempted after D-day (start of hostilities).

STAGING, OR MARRY-UP, PHASE

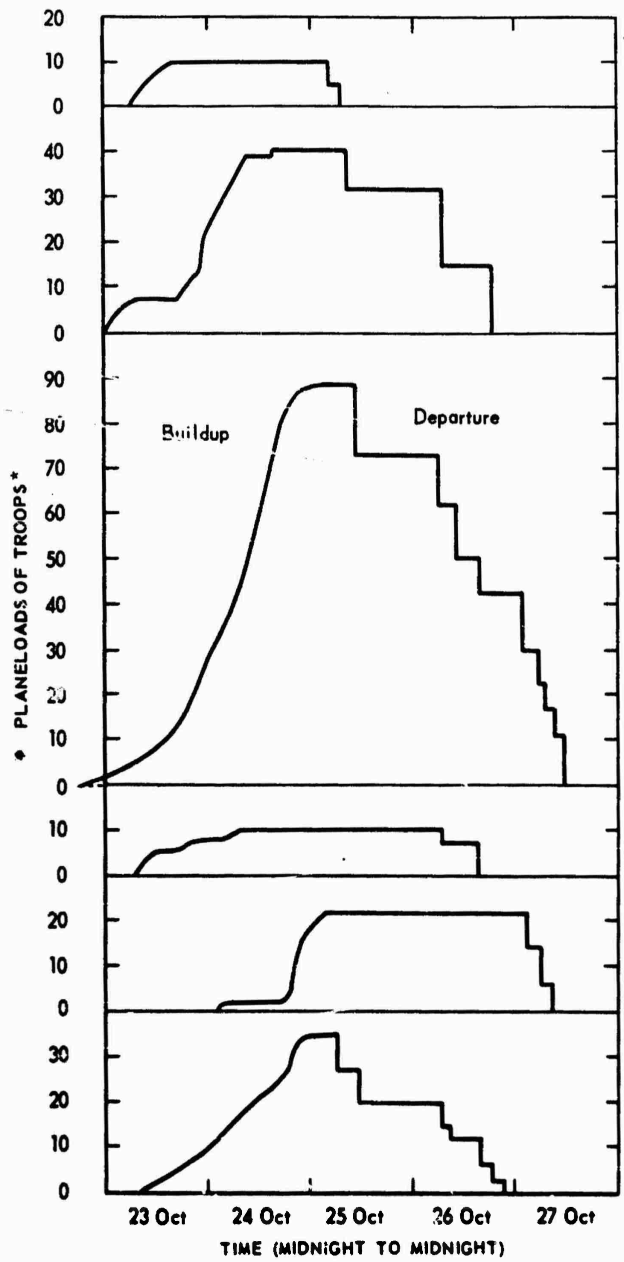
The situation at the staging areas was more critical than that at the air bases. Even though the AMG did an outstanding job in issuing the equipment, there was a period of high concentration that could not be avoided. Figure 17



Location	Concentration of troops		Periods[a]
	Max	Avg	
Toul-Rosières	200	60	1
Ramstein	300	80	1
Chambley	150	50	2
Sembach	150	50	10
Rhein/Main	400	160	1
Composite airstrip	700	330	3

[a]A period is 1 hr.

Fig. 16—Concentration of Troops at Air Bases
*Average 68 troops/aircraft.



Staging area	Percentage of total division troops
Lorsch	5
Pirmasens	20
Spesbach	43
Ramstein	5
Germersheim	10
Chenevières	17

Fig. 17—Concentration of Troops at Staging Areas
*Average 68 troops/aircraft.

shows that on BIG LIFT a maximum concentration of troops and materiel occurred at the six staging areas between 48 and 56 hr after the landing of the first plane. Except under the condition of a long period of tension with no overt hostile action the situation at the staging areas becomes untenable. One suitably placed nuclear weapon could have eliminated roughly half of the division; two weapons could have destroyed two-thirds of the division. Even when the operation is conducted during a period of tension, the possibility that theater augmentation by means of airlift might precipitate hostilities cannot be overlooked.

It is realized that peacetime circumstances dictated these concentrations, but planning for deployment in an actual emergency must include avoidance of this high degree of risk. It is also realized that although the equipment is always vulnerable while located at its storage sites, troop concentrations about the equipment (see Fig. 17) present a much more lucrative target.

It is logical that this risk should be reduced so that marry-up will have a greater probability of success, even if the vehicles must be diverted to a buildup of the existing theater force or issued to allies rather than to airlifted divisions. Rapid dispersion in company-sized units is an obvious solution, but dispersion also creates other problems.

First, the maintenance groups lack enough qualified personnel to disperse the vehicles with the necessary rapidity. This implies that some unit, perhaps the unit responsible for rear-area security, should be given the additional mission of supporting such dispersion.

Second, the equipment must be dispersed in such fashion that unit integrity will be preserved as much as possible but the equipment will still not present a profitable target. This means that an early reconnaissance of the areas surrounding the preposition sites is advisable. Smaller staging areas—perhaps company size—should be preselected and specific vehicles designated for these individual areas. Since they will be used only in the event of hostile action, the areas need not be confined to a peacetime selection. Movement plans must include consideration of precipitous concentrations of other traffic, including the movement of ammunition and POL (petroleum, oils, and lubricants). A contingency plan outlining actions to be taken on an alert is required. In connection with this, it is interesting to note that although a destruction plan to prevent capture may exist, not all personnel are familiar with its provisions, and an adequate capability for destruction does not seem to exist within the maintenance group. Support would be required should destruction become essential.

Third, guards must be furnished during the dispersion period and guides must be furnished from the air bases to the dispersed areas. Transportation plans for this comparable period during BIG LIFT appeared to operate well, since the location of the staging areas was well known and the advance party furnished all the guiding necessary.

Fourth, theater maintenance support will be severely taxed by resident units during this period and provisions must be made for appropriate allocation of existing support to TI and necessary repair of prepositioned equipment at the dispersed sites.

Fifth, it is likely that the process of deployment would be slower than it was during the airlift for BIG LIFT. Although the issue procedures worked very well during BIG LIFT, some future exercise could well test the effect of such dispersion on the rapidity of the marry-up, whether equipment was issued to airlifted troops or to hastily mobilized allied units.

MANEUVER PHASE AND RELIABILITY

GENERAL

Although there were five distinct phases of the maneuver (march to assembly area, FTX, return march, turn-in, and restorage), the overlap in repair actions—with one exception—was so extensive that it is difficult to distinguish the effect of each phase on the equipment. The exception was the march of the 2d Armd Div to the assembly area. This was very closely observed by representatives from every interested agency in the US and allied countries, and repairs made in bivouac before the FTX tended to isolate the effects of the march. The 3d Armd Div was not subjected to such close scrutiny, but RAC observers with the 3d Armd Div were able to collect similar data from the division sample (including bivouac repairs) in sufficient quantity to make a general comparison of performance possible. Although the entire maneuver is aggregated in the following analysis, the march to the forward assembly area is analyzed separately as a check on the results of the aggregation.

During the FTX and the return march, units frequently operated separately, repairs were made or deferred as dictated by the situation, and records for tactical units were maintained in many places; as deferred repairs merged into the reporting of the next phase, obtaining complete reports of each phase became virtually impossible.

Unfortunately for statistical purposes the restorage phase of 2d Armd Div equipment is not complete as of this writing and it is probable that it will never be completed. About 5000 vehicles will be turned in for more modern equipment; repairs not completed at that time will remain incomplete or will be lost to the record. Reports of performance during the maneuver phase therefore rely heavily on those repairs obtainable from the sample.

MARCH TO THE FORWARD ASSEMBLY AREA

Three official control centers were established to monitor the march of the 2d Armd Div to the assembly area. Their work was interestingly and efficiently interrelated and co..dinated, but only a fraction is pertinent to this report. The MCC was the principal source of data for the airlift phase previously reported. Although it was intimately concerned in movement during all phases, no further data were requested from this unit. The SACC, whose principal mission was coordination of staging-area activities and clearance of the march units, was likewise used not for source data but only for confirmatory checks. The logs of the OCC, which had the mission of coordinating Ordnance support of the march, and the reports of RAC observers accompanying selected units furnished the basic data for the following analysis.

On the routes of the march seven platoon bases had been established with attached roving patrols—a base at each of the four staging areas, with backup furnished by three fixed Ordnance installations. The 2d Armd Div maintenance battalion was marched as a unit and was not required to function as a maintenance unit.

The maintenance rule adopted for the march was that repairs requiring less than ½ hr were to be done on the road, repairs requiring less than 4 hr were to be accomplished at the bases, and repairs requiring more than 4 hr would justify issue of a direct-exchange (DX) float vehicle. This rule was not strictly adhered to and the number of exceptions was substantial. In the following text, a repair time exceeding 6 m-hr is considered evidence of a major repair or replacement requirement, such that the vehicle would have been out of action until normal support was established.

Failure Data

For the entire division the OCC reported 257 identifiable failures, or dropouts, 68 of which were in the sample units. At the same time the RAC teams reported 93 dropouts in the same sample units. After duplications were removed, it was determined that there must have been at least 132 dropouts in the sample, indicating reporting accuracies of 52 percent in OCC logs and 70 percent in RACFOE reports. From these estimates of error, assuming that 100 percent of major failures were reported, it is estimated that there were at least 441 dropouts in 2d Armd Div during the march. The cause of a great many dropouts was attributed by observers to driver unfamiliarity with a recently issued vehicle. One common cause of dropout, for example, was overheating.

The failure data for the 2d Armd Div on the march to the assembly area is presented in Table 13. The vehicles of the 2d Armd Div averaged slightly over 100 miles during this march, about the same as the 3d Armd Div. A substantial number of repairs was deferred until assembly at the bivouac area; since these repairs were directly attributable to the march, they are also included in Table 13. Also included are comparable failure percentages for the 3d Armd Div, derived from the sample reports adjusted for errors of estimate in extrapolation. The percentage of reported "critical" failures is lower in 3d Armd Div than in 2d Armd Div. Interestingly, 3d Armd Div had about two-thirds as many dropouts as 2d Armd Div during the march but deferred about twice as many repairs to bivouac as the 2d Armd Div. In addition, observer reports indicated an unknown number of third-echelon repairs performed by second-echelon units with parts furnished by the 3d Armd Div maintenance battalion or obtained by lateral transfer. This procedure was not nearly so prevalent in the bivouac area as it was in the later phases, but it does leave unresolved the question of the accuracy and completeness of the records.

From the above data it is generally concluded that, although apparently significant differences in performance were recorded, the reporting bias may

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TABLE 13

Vehicle Failures in the March to Assembly Area, 2d Armd Div

(Approximately 100 miles)

Vehicle	March failure											Bivouac failure[a]				Total[b]	
	Total in march	OCC logs	Estimated actual dropouts	Estimated percentage	Repair time						Float (DX)	Repair time					
					< 1 m-hr	Percentage[c]	1–6 m-hr	Percentage[c]	> 6 m-hr[bd]	Percentage		<6 m-hr	Percentage	>6 m-hr[d]	Percentage	>6 m-hr[d]	Percentage
Truck																	
¼-ton	1069	28	51	4.8	22	2.1	24	2.2	5	0.5	4	22	2.1	18	1.7	23	2.2
¾-ton	653	12	20	3.1	12	1.9	4	0.6	4	0.6	[illegible]	10	1.5	6	0.9	10	1.5
2½-ton	942	32	60	6.4	42	4.4	14	1.6	4	0.4	[illegible]	12	1.3	13	1.4	17	1.8
5-ton	434	32	55	12.6	26	5.9	20	4.6	9	2.1	0	20	4.6	13	3.0	22	5.1
10-ton	24	3	4	16.6	2	8.3	0	0	2	8.3	0	—	—	—	—	2	8.3
Tank	398	36	69	15.6	26	4.8	33	8.3	10	2.5	4	17	4.3	4	1.1	14	3.5
APC	571	101	163	28.6	52	9.1	72	12.5	39	7.0	11	34	6.0	11	1.9	50	8.8
SP artillery	106	12	18	18.8	4	5.4	10	9.6	4	3.8	0	4	3.8	0	0	4	3.8
Miscellaneous	32	1	1	3.1	0	0	0	0	1	3.1	0	—	—	—	—	1	3.1
Total	1229	257	441	10.3	186	4.3	177	4.2	78	1.8	20	119	2.8	65	1.5	143	3.3
3d Armd Div percentage[e]	—	—	—	7.0	—	4.4	—	1.7	—	0.9	—	—	5.3	—	1.2	—	2.1

[a] From third-echelon work orders.
[b] Includes repair of DX'd vehicle.
[c] Corrected for error of estimate.
[d] Critical major repair or replacement.
[e] Estimated from sample; adjusted for sampling error.

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have been high enough to affect the results. Accordingly, the performance ratios are acceptable only as a check on the final data.

Repairs and Replacements

The characteristics of the repairs and replacements in both divisions occasioned by 100-mile marches are given in Table 14. In this table the Ordnance work orders are used only when there were no observed failures in the sample or when the actual numbers exceeded the extrapolated sample.

Table 15 recapitulates the component replacements on a unitized basis (100 vehicles/100 miles) and gives a notion of the composition of the ASL/AOSL for approximately 1 day's operation.

MANEUVER PERFORMANCE AND RESTORAGE

All movement, from staging area to return to storage area and including the FTX, is treated as maneuver. Odometer readings in the sample were used to determine the average distances traveled by each type of vehicle and the results are shown in Table 16. Mileage recorded in Table 16 was accumulated on the 9 movement days, but the maneuver period is taken to be 13 to 14 days. In this time, 2d Armd Div wheeled vehicles moved approximately 1000 miles and tracked vehicles moved about 500 miles. The mileage accumulation in 3d Armd Div was somewhat less. In the following analysis the results are adjusted for this difference. In the last 2 days of the FTX, repair actions dropped considerably and on the return march were less than half those on the forward march, even though the same reporting control was established. Unit integrity was not preserved, even in the sample; consequently the observer reports suffered. Ordnance repair records of the 3d Armd Div after the exercise are reasonably complete; but for the 2d Armd Div and prepositioned equipment, sampling must suffice.

Repair data were obtained from both divisions only with considerable difficulty and it is not certain that the degree of completeness was the same for each. On the other hand, replacement data were deemed to be much more complete and could be checked by means of Ordnance supply records.

Prepositioned vs Standard Equipment

Comparison of the prepositioned equipment with the equipment of the 3d Armd Div taken as standard is made on the basis of seven selected major replacement parts (see Table 17). The maneuver performance shown in the table is the ratio of replacements of major assemblies in typical theater units, used as the standard, to replacements in prepositioned vehicles. On the first day of movement for the 2d Armd Div—the march to the assembly area—the wheeled vehicles as a whole outperformed the tracked vehicles, largely because of the poor performance of the M59 APCs.

The results of the entire maneuver can be extrapolated from samples that show that (a) the M38-class ¼-ton started to fail more rapidly than the M151, (b) the prepositioned M37-class ¾-ton remained better than standard (probably because of a high percentage of new vehicles), (c) the prepositioned

TABLE 14

Third-Echelon Repairs and Major Assembly Replacements, by Type, in First 100 Miles

Component replaced or repaired	Kind of vehicle[a]																											
	¼-ton truck				¾-ton truck				2½-ton truck				5-ton truck				APC				Tank				SP artillery			
	b	c	d	e	b	c	d	e	b	c	d	e	b	c	d	e	b	c	d	e	b	c	d	e	b	c	d	e
3d Armd Div (Typical Theater Division)																												
Replacement																												
Engine	3	12	2	12	0	0	0	0	5	16	11	16	2	6	8	8	2	6	6	6	4	12	7	12	0	0	0	0
Transmission	1	4	1	4	1	6	2	6	0	0	1	1	0	0	2	2	4	12	6	12	2	6	3	6	0	0	1	1
Differential	1	4	1	4	0	0	1	1	0	0	0	0	0	0	0	0	1	3	6	6	–	–	–	–	–	–	–	–
Final drive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0	0	0	0	0	0
Clutch	2	8	7	8	0	0	1	1	3	10	1	10	2	6	5	6	0	0	0	0	0	0	0	0	0	0	0	0
Transfer	0	0	0	0	1	6	1	6	0	0	1	1	0	0	1	1	1	3	1	3	0	0	0	0	0	0	0	0
Axle	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steering	0	0	0	0	0	0	0	0	0	0	0	0	2	6	2	6	0	0	0	0	0	0	0	0	0	0	0	0
Repair																												
Engine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	2	8
Transmission	0	0	3	3	0	0	0	0	1	3	1	3	0	0	1	1	1	3	1	3	0	0	2	2	0	0	0	0
Differential	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	–	–	–	–
Final drive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0	0	0	0	0	0
Clutch	0	0	0	0	0	0	0	0	2	6	1	6	1	3	2	3	0	0	0	0	0	0	0	0	0	0	0	0
Transfer	1	4	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Axle	0	0	0	0	0	0	0	0	0	0	0	0	0*	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Steering	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proportion	4.0				5.9				3.2				3.2				4.0				3.0				4.2			
Total vehicles	976				598				883				444				654				877				76			
2d Armd Div (Prepositioned Equipment)																												
Replacement																												
Engine	3	11	6	11	0	0	3	3	3	9	7	9	1	3	7	7	5	17	16	17	2	6	3	6	0	0	2	2
Transmission	2	8	5	8	0	0	3	3	1	3	2	3	0	0	0	0	4	13	12	13	1	3	6	6	1	6	4	6
Differential	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	20	2	20	–	–	–	–	–	–	–	–
Final drive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0	0	0	0	0	0	0	0	0	0
Clutch	4	15	5	15	0	0	0	0	1	3	1	3	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0
Transfer	0	0	1	1	0	0	0	0	1	3	1	3	0	0	1	1	1	3	0	3	0	0	0	0	0	0	0	0
Axle	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steering	0	0	1	1	0	0	1	1	0	0	3	3	1	3	6	6	0	0	0	0	0	0	0	0	0	0	0	0
Repair																												
Engine	0	0	6	6	0	0	1	1	1	3	3	3	0	0	2	2	5	17	7	17	1	3	1	3	2	12	0	12
Transmission	0	0	2	2	0	0	1	1	2	6	0	6	0	0	0	0	0	0	0	0	1	3	0	3	0	0	0	0
Differential	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	3	–	–	–	–	–	–	–	–
Final drive	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	0	0	0	0	0	0	0
Clutch	0	0	4	4	0	0	0	0	0	0	2	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Transfer	3	0	0	0	0	0	0	0	1	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Axle	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steering	0	0	2	2	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	1	3	1	3	0	0	0	0
Proportion	3.7				5.3				2.9				3.1				3.3				2.6				5.9			
Total vehicles	1069				653				942				434				571				398				106			

[a]Ten-ton trucks not included because quantity studied was too small to be conclusive.
[b]Reported by RACFOE teams in sample units.
[c]Extrapolation of sample report by means of proportion in sample.
[d]Ordnance work orders from entire division.
[e]Best estimate of number of repairs, DXs, and replacements.

TABLE 15

Estimate of Requirements for Selected Major Assemblies per 100 Vehicles/100 Miles

("Standard" means equipment of the 3d Armd Div, shown for comparison)

Component	Kind of vehicle													
	¼-ton truck		¾-ton truck, M37		2½-ton truck		5-ton truck, M54		APC		Tank		SP artillery, M52	
	M38 prepositioned	M151 standard	Prepositioned	Standard	M34 prepositioned	M35 standard	Prepositioned	Standard	M59 prepositioned	M113 standard	M48 prepositioned	M60 standard	Prepositioned	Standard
Engine	1.03	1.23	0.46	—	0.95	1.83	1.62	1.80	2.98	0.92	1.51	2.52	1.82	—
Transmission	0.74	0.41	0.46	1.00	0.32	0.11	—	0.45	2.28	1.84	1.51	1.26	5.66	1.33
Differential	—	0.41	—	0.10	—	—	—	—	3.50	0.92	—	—	—	—
Clutch	1.40	0.82	—	0.10	0.32	1.14	0.92	1.35	—	—	—	—	—	—
Transfer	0.09	—	—	1.00	0.32	0.11	0.23	0.23	0.52	0.46	—	—	—	—
Axle	—	—	0.31	0.10	—	—	—	—	—	—	—	—	—	—
Steering	0.09	—	0.15	—	0.32	—	1.38	1.35	—	—	—	—	—	—

TABLE 15

Estimate of Requirements for Selected Major Assemblies per 100 Vehicles/100 Miles

("Standard" means equipment of the 3d Armd Div, sh ... for comparison)

Component	Kind of vehicle													
	¼-ton truck		¾-ton truck, M37		2½-ton truck		5-ton truck, M54		APC		Tank		SP artillery, M52	
	M38 prepositioned	M151 standard	Prepositioned	Standard	M34 prepositioned	M35 standard	Prepositioned	Standard	M59 prepositioned	M113 standard	M48 prepositioned	M60 standard	Prepositioned	Standard
Engine	1.03	1.23	0.46	—	0.95	1.83	1.62	1.80	2.98	0.92	1.51	2.52	1.82	—
Transmission	0.74	0.41	0.46	1.00	0.32	0.11	—	0.45	2.28	1.84	1.51	1.26	5.66	1.33
Differential	—	0.41	—	0.10	—	—	—	—	3.50	0.92	—	—	—	—
Clutch	1.40	0.82	—	0.10	0.32	1.14	0.92	1.35	—	—	—	—	—	—
Transfer	0.09	—	—	1.00	0.32	0.11	0.23	0.23	0.52	0.46	—	—	—	—
Axle	—	—	0.31	0.10	—	—	—	—	—	—	—	—	—	—
Steering	0.09	—	0.15	—	0.32	—	1.38	1.35	—	—	—	—	—	—

M34–M35-class 2½-ton performed as well as the standard, and (d) the 5-ton vehicle also performed as well as the standard.

The SP artillery apparently performed better than standard, but the data on these vehicles are not considered reliable, since they are too meager for valid comparison. The M59 APCs and the M48-class tanks performed much more poorly than the standard counterparts, M113 APCs and M60-class tanks.

TABLE 16

Average Distances Traveled by Vehicles during Maneuver

(Weighted average based on entire-division densities)

Vehicle	2d Armd Div[a]	3d Armd Div[b]	2d Armd Div mileage/ 3d Armd Div mileage
Truck			
¼-ton	1143	976	1.17
¾-ton	1043	706	1.48
2½-ton	544	527	1.03
5-ton	696	567	1.23
10-ton	1165	575	2.03
Tank	475	369	1.29
APC	511	341	1.50
SP artillery	375	259	1.45
Total	778	604	1.29

[a]Average, 13 days' operation.
[b]Average, 14 days' operation.

The DA decision to replace the M38 class, the M59 class, and the M48 class is considered justified in the light of the above evaluation of performance. An additional bonus is to be expected in the beneficial impact on the supply system when the substitution is complete, i.e., reduction in stockage of parts and line items.

Maintenance Procedure

With the return of the vehicles from the exercise, the storage site at Chenevières was abandoned and a new site at Idar-Oberstein was opened. There was some restationing of units to accommodate the increased number of vehicles in the ROAD conversion. The 2d Armd Div personnel departed for CONUS almost immediately after turn-in but left a sizable maintenance group behind to assist in the preparation of the vehicles for restorage. This maintenance effort varied from station to station, but very little of it was thorough, judged by the huge workload left to the maintenance group.

The new maintenance procedure, based on the S inspection and repair and the preservation processing recently adopted, was started as soon as possible. The initial cycle, scheduled for the first 6 months, has been completed at only one installation. Turn-in of old vehicles and reception of new vehicles is in process. Scheduling to comply with the 6-month cyclic maintenance can be affected adversely by these transfers and the steady state can hardly be achieved until the substitution is complete.

[redacted]

TABLE 17

Replacement of Selected Major Assemblies as a Measure of Comparative Performance of Standard and Prepositioned Equipment

("Standard" means equipment of the 3d Armd Div, shown for comparison)

Category	¼-ton truck				¾-ton truck				2½-ton truck				5-ton truck				APC				Tank				SP artillery			
	Standard		Prepositioned		Standard		Prepositioned		Standard		Prepositioned		Standard		Prepositioned		Standard		Prepositioned		Standard		Prepositioned		Standard		Prepositioned	
	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation	Sample	Extrapolation
	Replacements																											
Engine																												
March	3	12	3	11	0	0	0	3[b]	5	16	3	10	2	6	1	3	2	8	5	17	4	12	2	6	0	0	0	2[b]
FTX	8	32	4	15	1	6	0	3[b]	6	19	3	10	1	3	3	9	3	12	2	7	8	24	3	8	4	16	0	1[b]
March	5	20	3	11	0	0	0	0	0	0	1	3	0	1[b]	0	0	1	4	2	7	1	3	2	5	0	0	1	6
Deferrals	5	20	9	92[a]	1	6	0	0	1	3	2	62[a]	0	3[b]	0	3[b]	3	12	6	31[a]	4	12	4	26[a]	0	0	0	2[b]
Total	21	84	19	129	2	12	0	0	12	38	8	85	3	9	4	12	9	36	15	62	17	51	9	45	4	16	1	6
Transmission																												
March	1	4	2	8	1	6	0	1[b]	0	1[b]	1	3	0	2[b]	0	0	4	16	4	13	2	6	1	3	0	1[b]	1	6
FTX	3	12	1	4	0	0	0	0	3	10	2	6	1	3	2	6	2	8	7	23	2	6	4	10	0	0	0	1[b]
March	0	0	0	0	0	0	0	0	0	0	0	0	0	1[b]	0	0	0	0	5	17	0	0	2	5	0	0	1	6
Deferrals	7	28	7	71[a]	1	6	1	0	1	3	0	2[b]	2	6	0	2[b]	1	4	11	56[a]	2	6	6	39[a]	0	1[b]	0	0
Total	11	44	10	83	2	12	1	0	4	13	3	9	3	9	2	6	7	28	27	109	6	18	12	60	0	0	2	12
Differential and final drive																												
March	1	4	0	0	0	1[b]	0	0	0	0	0	0	0	0	0	0	1	4	2	7	0	0	0	0	0	0	0	0
FTX	0	1[b]	0	1[b]	0	4[b]	0	0	0	0	1	3	0	0	0	0	1	4	1	3	0	0	2	5	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	3	10	0	0	0	0	0	0	0	2[b]	1	3	0	0	0	0
Deferrals	0	1[b]	1	10[a]	0	1[b]	0	0	0	0	0	1[b]	0	0	2	16[a]	1	4	4	20[a]	0	0	0	1[b]	0	0	0	0
Total	1	4	1	10	0	0	0	0	0	0	1	3	3	10	2	16	3	12	7	30	0	0	3	8	0	0	0	0
Clutch																												
March	2	8	4	15	0	1[b]	0	0	3	10	1	3	2	6	1	3	0	0	0	0	0	0	0	0	0	0	0	0
FTX	4	16	7	26	0	2[b]	0	1[b]	2	6	0	3[b]	1	3	1	3	0	0	1	3	0	0	0	0	0	0	0	0
March	1	4	1	4	0	0	0	0	3	10	1	3	0	2[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferrals	2	8	11	112	0	1[b]	0	1[b]	0	0	2	6[b]	1	3	1	8[a]	0	0	0	0	0	0	0	0	0	0	0	0
Total	9	36	23	157	0	0	0	0	8	26	0	6	4	12	2	14	0	0	1	3	0	0	0	0	0	0	0	0
Transfer																												
March	0	0	0	2[b]	1	6	0	0	0	1[b]	1	3	0	1[b]	0	1[b]	1	4	0	0	0	0	0	0	0	0	0	0
FTX	0	0	0	1[b]	0	1[b]	1	5	0	3[b]	1	3	1	3	1	3	4	16	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1[b]	1	4	0	0	0	0	0	0	0	0	0	0
Deferrals	0	0	3	31[a]	1	6	1	8[a]	1	3	0	0	0	0	0	0	0	2[b]	0	1[b]	0	0	0	0	0	0	0	0
Total	0	0	3	31	2	12	2	13	1	3	2	6	1	3	0	3	6	24	0	0	0	0	0	0	0	0	0	0
Axle																												
March	0	0	0	0	0	1[b]	0	1[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FTX	0	1[b]	0	2[b]	1	6	0	1[b]	1	3	0	1[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Total	11	[illegible]	10	83	2	12	1	0	4	13	3	9	3	9	2	6	7	28	27	109	6	18	12	60	0	0	2	12
Differential and final drive																												
March	1	4	0	0	0	1[b]	0	0	0	0	0	0	0	0	0	0	1	4	2	7	0	0	0	0	0	0	0	0
FTX	0	1[b]	0	1[b]	0	4[b]	0	0	0	0	1	3	0	0	0	0	1	4	1	3	0	0	2	5	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	3	10	0	0	0	0	0	0	0	2[b]	1	3	0	0	0	0
Deferrals	0	1[b]	1	10[a]	0	1[b]	0	0	0	0	0	1[b]	0	0	2	16[a]	1	4	4	20[a]	0	0	0	1[b]	0	0	0	0
Total	1	4	1	10	0	0	0	0	0	0	1	3	3	10	2	16	3	12	7	30	0	0	3	8	0	0	0	0
Clutch																												
March	2	8	4	15	0	1[b]	0	0	3	10	1	3	2	6	1	3	0	0	0	0	0	0	0	0	0	0	0	0
FTX	4	16	7	26	0	2[b]	0	1[b]	2	6	0	3[b]	1	3	1	3	0	0	1	3	0	0	0	0	0	0	0	0
March	1	4	1	4	0	0	0	0	3	10	1	3	0	2[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferrals	2	8	11	112[a]	0	1[b]	0	1[b]	0	0	2	6[b]	1	3	1	8[a]	0	0	0	0	0	0	0	0	0	0	0	0
Total	9	36	23	157	0	0	0	0	8	26	0	6	4	12	2	14	0	0	1	3	0	0	0	0	0	0	0	0
Transfer																												
March	0	0	0	2[b]	1	6	0	0	0	1[b]	1	1	0	1[b]	0	1[b]	1	4	0	0	0	0	0	0	0	0	0	0
FTX	0	0	0	1[b]	0	1[b]	1	5	0	3[b]	1	3	1	3	1	3	4	16	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1[b]	1	4	0	0	0	0	0	0	0	0	0	0
Deferrals	0	0	3	31[a]	1	6	1	8[a]	1	3	0	0	0	0	0	0	0	2[b]	0	1[b]	0	0	0	0	0	0	0	0
Total	0	0	3	31	2	12	2	13	1	3	2	6	1	3	0	3	6	24	0	0	0	0	0	0	0	0	0	0
Axle																												
March	0	0	0	0	0	1[b]	0	1[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FTX	0	1[b]	0	2[b]	1	6	0	1[b]	1	3	0	1[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferrals	0	0	0	0	1	6	1	8[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	2	12	1	8	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Steering																												
March	0	0	0	1[b]	0	0	0	0	0	0	0	0	2	6	1	3	0	0	0	0	0	0	0	0	0	0	0	0
FTX	0	0	0	0	0	0	0	1[b]	0	0	0	0	1	3	0	1[b]	0	0	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deferrals	1	4	3	31[a]	0	0	0	0	0	0	0	0	0	0	2	16[a]	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	4	3	31	0	0	0	0	0	0	0	0	3	9	3	19	0	0	0	0	0	0	0	0	0	0	0	0
All categories	43	172	59	441	8	48	4	29	27	86	16	109	17	52	15	70	25	100	50	204	23	69	24	105	4	16	3	18

Computations

Vehicles	976	1,069	598	653	883	942	444	434	654	571	477	398	76	106
Average miles	976	1,143	706	1,043	527	544	567	696	341	511	369	475	259	375
Vehicles × miles	952,576	1,221,867	422,188	681,079	465,341	512,448	251,748	302,064	223,014	291,761	176,013	189,050	19,684	39,750
Reciprocal of sample proportion	4.0	3.7	5.9	5.3	3.2	2.9	3.2	3.1	4.0	3.3	3.0	2.6	4.2	5.9
Postexercise-sample multiplier		10.2		7.7		31.0		8.5		5.1		6.5		
Division estimate of replacements/100 vehicles/100 miles	1.81	3.61	1.14	.43	1.85	2.13	2.07	2.32	4.48	7.0	3.92	5.55	0.81	0.45
Replacements														
Maneuver performance	.49[c]		2.65[c]		.87		.89		.64[c]		.71[c]		1.80[c]	
March performance	.97		d		1.46		[illegible]		.76		1.67		0.00[e]	

[a]Extrapolated from data taken from Kaiserslautern, [illegible], and Idar-Oberstein.
[b]Ordnance reports, no incident in sample, not included in totals for calculation of maneuver performance; sample was used only for this estimate.
[c]Indicates that performance of 2d Armd Div was statistically significantly different from that of 3d Armd Div.
[d]Value indeterminate mathematically, but 2d Armd Div statistically significantly better than 3d Armd Div.
[e]Although the ratio is 0, the numbers were too small for the value to be significant.

At that time the distribution of vehicles will be approximately like that shown in Table 18, which includes all equipment from both prepositioned divisions and support elements; also included are the personnel strength assigned to each location and the ratio of mechanics to vehicles. These points will be discussed in the section "Current Organization and Workload."

RELIABILITY

Definition

For the purposes of this paper, "reliability" of the equipment is taken to be an adaptation of the definition of deployment serviceability given in Ref 2, Par 74, which states:

> Deployment Serviceability Standards.
> a. An item is considered to meet standards of deployment serviceability when it is capable of performing at its rated capacity the function for which it was designed, and can be maintained in a serviceable condition in combat until major item replacement or fourth echelon repair can be effected in the operations area (estimated 90 days). [Underscoring added.]

The term "major item" connotes a "final combination of end products, component parts and/or materials which is ready for its intended use," e.g., a vehicle, ship, or aircraft.[3] One interpretation is that it is estimated that 90 days is required to establish a maintenance float of adequate size combined with a fourth-echelon capability for maintaining the size of the float.

A more meaningful measure of reliability is obtained by considering time to the first major-assembly replacement. Reliability of a group or fleet of major items must depend on the system that supplies the replacement assembly, even though controlled cannibalization is permitted. This definition of reliability is considered consistent with unit preparation for oversea movement (POM) deployment serviceability and leads to a more substantial evaluation of the sustained availability of the vehicles during operation and of the mobility status of the unit at any point in time.

The time to first major-assembly replacement can be used as a measure of period reliability (see App B). Period reliability is defined as the percentage of vehicles not requiring a major-assembly replacement after a designated period of operation. According to POM requirements, 90 days may be considered a suitable period under the above definition of reliability, but prescribed stockage levels act to reduce this period and make shorter periods also of interest.

By extrapolating from the BIG LIFT data, it is possible to estimate the reliability of the prepositioned 2d Armd Div fleet for any period of time. Using the 3d Armd Div vehicular performance as typical of the Seventh Army, a comparative evaluation can be made of the vehicles as operated by the 2d Armd Div.

Current Situation

As discussed previously, it is planned to substitute more modern equipment for a substantial portion of the prepositioned material. The data obtained in BIG LIFT will not apply to the newly prepositioned vehicles but will be useful

TABLE 18

Approximate Distribution of Vehicles in Steady State, by Seventh Army Facility

Category	Kaiserslautern																	Idar-Oberstein, 9th Maint Bn					Germersheim, 7th Maint Bn					Pirmasens, 5th Maint Bn							
	6th Maint Bn											8th Maint Bn																							
	Hq	Bde Hq	Cav	MP Co	Tk	Tk	AI Dsr	Mech	Mech	Maint	Total	Arty	Arty	Arty	Arty	Arty	Total	Adm	Av	S&T	Med	Total	Bde Hq	Tk	Tk	Tk	Total	Engr	Sig	Bde Hq	Mech	Mech	Engr	Engr	Total
Truck																																			
1/4-ton[a]	37	27	76	8	39	39	10	47	47	32	323	31	31	31	21	17	131	13	17	16	22	68	27	39	39	39	144	44	24	27	47	47	31	31	251
3/4-ton	7	7	14	3	10	10	2	17	17	25	112	26	26	26	33	35	146	6	23	15	62	111	7	10	10	10	37	11	73	7	17	17	22	22	169
2 1/2-ton[b]	15	6	37	3	23	23	2	15	15	172	315	21	21	21	23	15	101	7	37	89	42	175	6	23	23	23	75	48	77	6	15	15	15	15	191
5-ton	—	1	20	—	20	20	—	11	11	30	113	18	18	18	30	1	85	—	1	34	—	35	1	20	20	20	61	89	1	1	11	11	47	47	207
10-ton	—	—	—	—	—	—	—	—	—	6	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	10
APC[a]	3	6	82	—	25	25	—	71	71	—	244	11	11	11	8	—	41	—	—	—	—	—	8	25	25	25	83	40	—	8	71	71	—	—	190
Tank[a]	—	—	28	—	63	63	—	7	7	4	172	2	2	2	2	—	8	—	—	—	—	—	—	63	63	63	129	6	—	—	7	7	—	—	20
SP howitzer	—	—	—	—	—	—	—	—	—	—	—	18	18	18	22	—	76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miscellaneous	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37	—	—	—	—	7	7	51
Total	65	89	217	14	180	180	14	168	168	269	1285	127	127	127	139	68	508	26	83	154	126	389	49	180	180	180	529	285	175	49	168	168	122	122	1089
Assigned strength plus group overhead (OH)											326						170					118					166								319
Automotive mechanics											188						93					67					91								140
Estimated wheeled-vehicle equivalents (WVE), including trailers											2250						950					450					950								1700
Ratio of mechanics to WVE											1:12						1:10					1:8					1:10								1:12

Category	Mannheim																							Karlsruhe														All facilities
	1st Maint Bn														4th Maint Bn									2d Maint Bn							3d Maint Bn							
	Inf	Inf	Inf	Inf	Inf	Sig	Hq	HSC	Bde Hq	Bde Hq	Bde Hq	Adm	MP	Total	Maint	S&T	Med	Trans	Tk	Arty	Arty	Arty	Total	Arty	Arty	Arty	Arty	Arty	Engr	Total	Tk	Tk	Cav	Mech	Mech	Hq	Total	
Truck																																						
1/4-ton[a]	51	51	51	51	51	24	28	9	27	27	27	13	8	418	32	16	22	27	44	26	26	25	218	31	31	31	21	17	44	175	39	39	76	47	47	—	248	1,976
3/4-ton	42	42	42	42	42	73	3	4	7	7	7	6	3	320	25	15	62	—	6	33	33	33	207	26	26	26	33	35	11	157	10	10	14	17	17	—	68	1,327
2 1/2-ton[b]	20	20	20	20	20	77	13	6	6	6	6	7	3	224	172	89	42	198	23	26	26	27	603	21	21	21	23	15	41	142	23	23	37	15	15	—	113	1,939
5-ton	1	1	1	1	1	1	—	—	1	1	1	—	—	9	20	34	—	3	27	19	19	1	123	18	18	18	30	1	89	174	20	20	20	11	11	—	82	889
10-ton	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—	18	24	—	—	—	—	—	10	10	—	—	—	—	—	—	—	50
APC[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	—	—	—	17	11	11	11	8	—	—	41	25	25	42	71	71	26	260	876
Tank[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	78	1	1	—	84	2	2	2	2	—	6	14	63	63	28	7	7	—	168	595
SP howitzer	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18	18	18	22	—	—	76	—	—	—	—	—	—	—	152
Miscellaneous	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	18	18	6	47	—	—	—	—	—	41	41	—	—	—	—	—	—	—	139
Total	124	124	124	124	124	175	44	19	41	41	41	26	14	971	269	154	126	228	200	123	123	110	1323	127	127	127	139	68	242	830	180	180	217	168	168	26	939	7,943
Assigned strength plus group OH														183									235							238							242	1,997
Automotive mechanics														70									126							113							131	1,019
Estimated WVE, including trailers														1150									1850							1350							1900	12,550
Ratio of mechanics to WVE														1:16									1:15							1:12							1:15	1:12

[a] Nearly all being replaced.
[b] Five hundred have been turned in for replacement.

for estimating performance of the outmoded equipment so long as it is retained for use in the theater. The new equipment may be evaluated similarly after a test.

The errors of the past should not be repeated when these newer vehicles are placed in storage; in particular, the vehicles should not be prepositioned unless they are in RFI condition. The placing of worn-out, unready vehicles into storage necessitated vast amounts of maintenance prior to BIG LIFT issue. The readiness and reliability of the vehicles were of doubtful quality because the condition of the vehicles was not known exactly. Effort expended in the proper preparation of these vehicles for storage will be repaid in an emergency.

An effort was made to utilize the BIG LIFT data to try to isolate deterioration due to open storage. Vehicles prepared early for BIG LIFT stood for as long as 3 months before issue. These vehicles were compared with vehicles prepared in the period just prior to the exercise, using the requirement for a third-echelon major-assembly replacement as the basis of comparison.

No effect on performance could be identified and existing evidence indicates that no appreciable deterioration occurred in 3 months. An attempt was made to isolate the effect of storage on the subsequent need for any repair, but again the results were inconclusive.

A controlled study of possible effects of deterioration is strongly indicated for at least two reasons: First, to ascertain the rate of deterioration, if any, and second, to determine an optimum period between maintenance inspections once the effect of deterioration was measured.

Restorage Phase

Several data problems arose as a result of the way the restorage phase of the 2nd Armd Div vehicles was conducted. The individual identity of the vehicles was lost during the restorage phase, and the fraction of vehicles requiring initial third-echelon major assembly during this phase had to be estimated from a restorage sample and from the failure observations of the maneuver phase. Despite (a) the fact that many vehicles were turned in right after BIG LIFT (either before or after the completion of necessary repairs), (b) the time interval between the end of BIG LIFT and this writing, and (c) the still uncompleted effort to re-store the equipment, the assumption had to be made that all replacements observed during this phase are attributable to operation during BIG LIFT.

In the 3d Armd Div, any major-assembly replacement occurring within 3 weeks after return to home station was considered to be attributable to the exercise. All vehicles were inspected within the 3-week period after the exercise because of the requirement for continued use.

It is difficult to explain the necessity for the large volume of replacements on practically all vehicle types after the exercise. Fully three times as many ¼-ton vehicles in the 2d Armd Div required major-assembly replacements during the restorage phase as in the maneuver phase. The vehicles were old but performed well during the exercise. The magnitude of the number of replacements after the exercise was quite unexpected. Certainly a great many vehicles were towed back to the prepositioning sites on the return march when many needed repairs were postponed, but this could only account for a small fraction of the replacements.

The possibility exists that the volume of major-assembly replacements was necessitated by use of different inspection criteria in preparation for restorage. However, maintenance personnel insist that the S service performed was identical to that performed before BIG LIFT.

Another possible explanation is that the vehicles deteriorated between the end of BIG LIFT and the time of the S. This deterioration would have caused some of the failures, and some of the subsequent replacements therefore would not be due to BIG LIFT. However, in the sample, at least half the major-assembly replacement occurred within $1\frac{1}{2}$ months after the end of BIG LIFT and the rest within 4 to 5 months. As was mentioned in the previous section, no noticeable effects of deterioration appeared after 3 months, and it is felt that deterioration would not have contributed significantly to the number of replacements. This hypothesis is also rejected.

The only remaining valid hypothesis is that movement during the maneuver was responsible for the seemingly excessive number of major-assembly failures.

Vehicle Performance

When the whole of the restorage phase is considered, failures of major assemblies in the 2d Armd Div $\frac{1}{4}$-ton vehicles were significantly more numerous than in the counterpart M151 vehicles of the 3d Armd Div. The DA decision to replace the prepositioned M38's with the more modern M151's appears justified from this comparison. It was the poor performance of the $\frac{1}{4}$-ton trucks that pulled down the average of all wheeled vehicles in the 2d Armd Div.

During the exercise it was learned that a number of new $\frac{3}{4}$-ton trucks had been received by the AMG during the period from September to October and had been issued to the 2d Armd Div. Many of the vehicles had been driven less than 100 miles and had not been prepositioned. It was virtually impossible to identify and treat all these new vehicles separately in the subsequent reporting. The sample indicated that new vehicles comprised about a fourth of the $\frac{3}{4}$-ton fleet but accounted, apparently, for only a seventh of the major-assembly replacements. The $\frac{3}{4}$-ton fleet in its entirety performed at least as well as the standard fleet.

As has been said, the $2\frac{1}{2}$- and 5-ton trucks in the 2d Armd Div performed slightly less effectively than those in the 3d Armd Div, but the differences could have occurred by chance and are not statistically significant. The vehicles in both divisions were of the same model type and with approximately the same entrance mileage. Postmaneuver data on the $2\frac{1}{2}$-ton truck are based on the M35's only, as all the M34's were turned in to depots shortly after the exercise. For performance evaluation the two vehicles are almost identical and indications are that the M34's performed as well as the M35's; consequently the M35's were considered representative of the $2\frac{1}{2}$-ton fleet.

The preparation for restorage of the tracked vehicles had an impact similar to that of the $\frac{1}{4}$-ton trucks. During the maneuver the APCs in the 2d Armd Div performed at a lower level—but not statistically lower—than those in the 3d Armd Div. However, the replacement rate of vehicles in the 2d Armd Div in the restorage phase was about equal to the rate during the maneuver. Consequently, performance of the prepositioned APCs turned out to be statistically lower than the 3d Armd Div APCs. The older M59 apparently cannot be expected to compare to the newer M113 in performance, judging by the rapid decay of its initial condition at the start of the maneuver. Present replacement of the M59's by M113's appears to be quite justified.

The tanks exhibited a somewhat higher rate of replacement after the maneuver, which also dropped them in performance to a level under that of the 3d Armd Div. The difference again is considered to result chiefly from the age of the older M48's. These vehicles are scheduled to be replaced by newer M60's.

Data from the restorage phase in the 2d Armd Div presented a different picture for the SP artillery, as a much smaller fraction of the vehicles needed major-assembly replacements than during the maneuver. Consequently, the performance of the prepositioned SPs remained above those in the 3d Armd Div. Samples were small, especially in the 3d Armd Div, and the accuracy of the period-reliability estimates (see the next section) does not justify a strong conclusion. However, the vehicles in both divisions are of practically the same age, and the SPs in the 2d Armd Div certainly performed no less effectively than those in the 3d Armd Div.

Reliability Estimates of Powered Vehicles

According to the definition of reliability given in "Definition," the percentage of vehicles not requiring a third-echelon major-assembly replacement after a specified period of operation will be used to compare the performances of the two divisions. Major-assembly replacements were chosen because the data available are the most reliable and because lack of the necessary replacement can be taken to indicate the loss of the vehicle for the designated period.

The above percentage, called the "period reliability," was calculated from an estimate of the mean life of the vehicles based on BIG LIFT data. The mean-life estimates consider only the initial third-echelon major-assembly replacement. Second failures and the nature of the repairs (whether one or more major assemblies were replaced at time of failure) were not considered.

Table 19 gives the estimate of period reliability based on an assumed usage rate of 1000 miles/month for each of the wheeled vehicles and 500 miles/month for each of the tracked vehicles. It was considered that these usage rates are close approximations of the mileage that would be traveled under sustained battle conditions. The values obtained from BIG LIFT data were adjusted for the differences in mileages traveled by the two divisions and then adjusted to the assumed usage rate.

All the differences between the period values for the two divisions are statistically significant, with the exception of the 2½- and 5-ton trucks. The actual significance, in terms of loss of combat effectiveness as mobility is lost, is not evaluated. The values for all wheeled and all tracked vehicles are presented, but for interest only, as each type of vehicle should be examined separately for meaningful results.

To summarize, it appears that the standard B vehicles (M38's, M59's, and M60's) lower the reliability of the entire prepositioned fleet for extended operation and have no place in prepositioned storage under the present concept of rapid reaction. Apparently even an extensive amount of preparatory maintenance will not revitalize them satisfactorily—an indication that the vehicles were approaching the end of their economic life when placed in storage.

TABLE 19

Estimates of Period Reliability

(Usage rate: 1000 miles/month/wheeled vehicle, 500 miles/month/tracked vehicle)

Vehicle	Period, days							
	30		45		60		90	
	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div	2d Armd Div	3d Armd Div
	Reliability, %							
Truck								
¼-ton	70	85	60	79	48	73	35	62
¾-ton	94	87	91	82	88	76	83	66
2½-ton	81	84	73	76	65	70	52	58
5-ton	78	79	68	70	59	63	46	49
All wheeled	79	84	71	77	62	71	49	59
Tank	78	82	68	74	59	68	46	55
APC	74	82	65	74	55	68	40	55
SP artillery	85	64	79	51	72	41	61	25
All tracked	76	81	66	73	57	65	44	52

Similar model vehicles of the 2d Armd Div (¾-, 2½-, and 5-ton wheeled vehicles and SP artillery) performed as well as or better than those in the 3d Armd Div and were able to retain the level of reliability given them by the preparatory maintenance effort.

Aside from certain other obvious advantages (such as the beneficial impact on the supply system) and with proper maintenance, it appears that prepositioning of vehicles of the same type as those in current use would promise a mobility capability equal to that of the theater fleets.

Relation between Period Reliability and Preparatory Maintenance Effort

Figure 18 is an attempt to measure the relation between the period reliability (in this case, 3000 miles in 90 days) and the magnitude of preparatory maintenance. The curve includes data from several LONG THRUST exercises and pre-BIG LIFT marches[1] performed in the AMG. The curve compares only the ¾-, 2½-, and 5-ton vehicles, which were the same models in all units. The value obtained for the established standard, the 3d Armd Div, is also portrayed with 95 percent confidence limits surrounding the average. This average for the 3d Armd Div is extended for illustrative purposes only and no conclusion about relation between average and preparatory man-hours is to be drawn. The vertical sizes of the other points reflect a similar confidence level around the estimate.

The preparatory-maintenance man-hours per vehicle for the various units are best estimates relying on recorded man-hours, which constituted the only available basis common to both LONG THRUST and BIG LIFT units.

A comparison based on time available could not be made. It is charged by the ARG that man-hours may have been improperly recorded internally;

however, since the same error factors affecting LONG THRUST records are presumed to be present in the BIG LIFT records, the relation between the points should not vary even though magnitudes may.

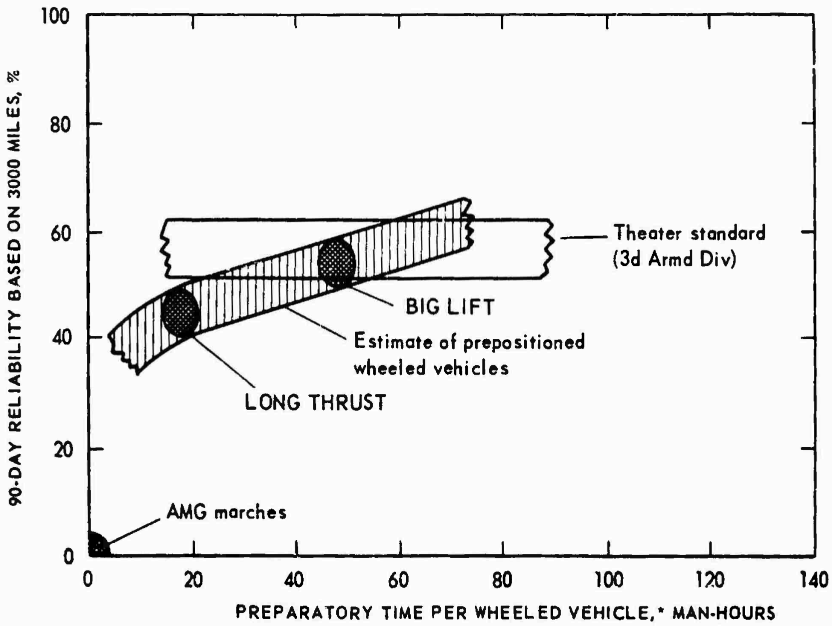


Fig. 18—Relation between Period Reliability and Amount of Preparatory Maintenance

*See text for derivation of magnitudes.

For the LONG THRUST units, 8.2 m-hr/wheeled vehicle was the recorded extent of the preparatory Q inspection. To this, adding 1 m-hr/vehicle for third-echelon repairs and 3 m-hr for organizational overhead (37 percent)[1] yields 12.2 m-hr/vehicle.

For BIG LIFT wheeled vehicles the estimate was arrived at from the sum of the following: 21 recorded m-hr/vehicle/S inspection in the sample, 8 m-hr for the road test, 5.5 recorded m-hr for TI with repairs, 3 m-hr/vehicle for third-echelon repairs, and 12.8 m-hr for overhead—a total of 50.3 recorded m-hr/vehicle. It should be noted that the man-hours recorded on the maintenance forms differ from the total man-hours reported or available (see the section "Preparatory Maintenance of Vehicles"). However, all these comparisons are made on the same basis, i.e., recorded man-hours.

The AMG value for the march is an extrapolation of the 22 percent of the vehicles requiring third-echelon maintenance after being driven 100 miles with no preparatory maintenance.[1] After 3000 miles the fraction of vehicles not having experienced a major-assembly replacement is very close to zero.

If it is assumed that all the vehicles came from a homogeneous sample (same age, same mileage distribution, same usage), the points for the prepositioned vehicles may be joined with the shaded curve resulting.

Two findings emerge. The first is that the current magnitude of the semiannual maintenance, about 32 m-hr/vehicle, should yield vehicles that will perform comparably with those in active units.

The second point, perhaps more interesting, is that after reaching the level of 12 to 18 m-hr the increase in man-hours expended per wheeled vehicle per maintenance inspection apparently does not proportionally increase the subsequent reliability, although at 18 m-hr the reliability is below theater standard. However, only three points were obtainable to plot the curve and periodic operational-readiness tests of selected equipment should be made to determine the shape of this curve more exactly. These tests, coupled with the deterioration study suggested earlier, will yield the appropriate (a) maintenance level to be prescribed and (b) interval between maintenance inspections.

Availability of Powered Vehicles

The proportions of vehicles available for service were very similar for the two divisions and no cognizance was taken of nonavailability caused by scheduled servicing. Table 20 shows the average values of daily availability during the maneuver. The values for the two divisions for the same class of vehicle are not statistically different.

TABLE 20

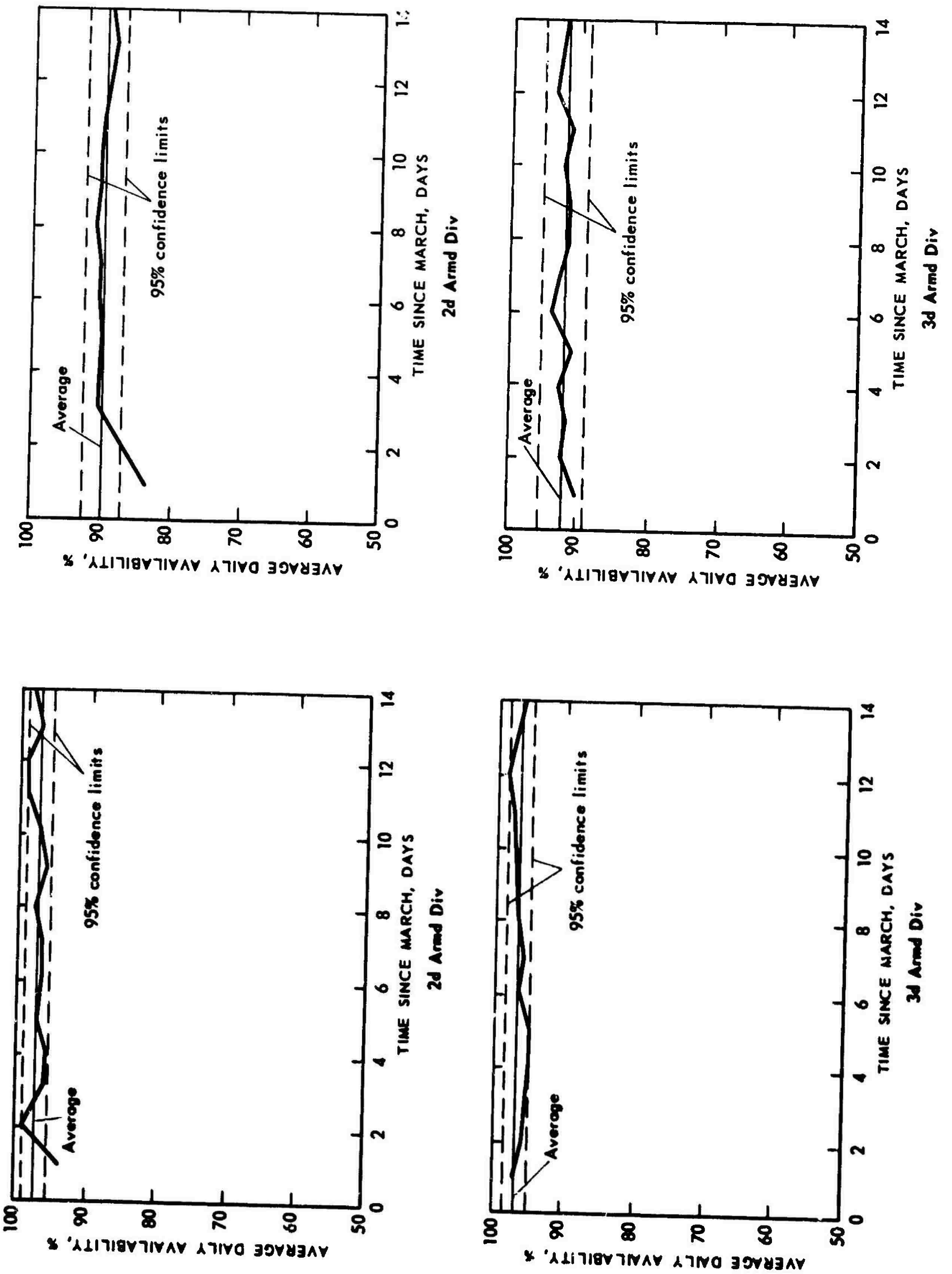
Average Daily Availability of Vehicles during BIG LIFT

Division	Available vehicles, %	
	Wheeled	Tracked
2d Armd Div	97	90
3d Armd Div	96	92

The values were calculated on the following basis: (a) all failures, both second- and third-echelon, were counted; (b) if a vehicle had a failure, it was considered lost for the entire day; and (c) vehicles DX'd or evacuated were considered lost for the duration of the exercise and the replacement vehicles were omitted from the calculation.

Two factors are important, however. The first is that the day-by-day availability for the two divisions was quite different. Figure 19 shows that the availability in the 3d Armd Div was quite constant during the entire maneuver period, but the availability for the 2d Armd Div was significantly worse at the beginning. On the day of the march (Day 1) the values for both wheeled and tracked vehicles were statistically significantly lower than the average. No value in the 3d Armd Div was statistically different from the average. The march, then, apparently took a much heavier toll of the 2d Armd Div than of the 3d Armd Div.*

*A check was made to determine whether the vast amount of control data (data from the OCC as well as from the sample) may have caused availability on the march day to appear excessively low, i.e., perhaps no more vehicles failed, but more of the failures were reported. This possible explanation is rejected, however, because when availability was calculated using sample reports as the only source, the same low point persisted and it remained significantly different.



a. Wheeled Vehicles

b. Tracked Vehicles

Fig. 19—Average Daily Availability of Vehicles during BIG LIFT
March is Day 1.

A second point to consider is that the 2d Armd Div was supported by some 25 ordnance units during Operation BIG LIFT. Consequently a much smaller fraction of the vehicles was deadlined for parts than in the 3d Armd Div. This factor produces a higher availability for the 2d Armd Div than it would have had, given only the same level of support as the 3d Armd Div.

Nonautomotive Equipment

An examination was made of the failure rate of equipment other than automotive in the sample unit, with a negligible number recorded. All observers were required to report on failures of selected high-density items representative of the Technical Services and of the materials of construction. A number of signal-equipment items had minor failures, but repairs were usually prompt and apparently presented no major drain on the supply system.

EVALUATION

CONCLUSIONS OF THE PREVIOUS STUDY

In the overall evaluation of the prepositioning concept the conclusions of the previous study are pertinent. All but two of those conclusions have been resubstantiated in the foregoing text. Although BIG LIFT provided no new data in the areas of (a) utilization of locally procured labor (indigenous personnel) for the custodial mission and (b) adequacy of the facilities at the storage sites, they are nevertheless considered of sufficient importance for reiteration. Data leading to earlier conclusions on these subjects are given in "Study of the Prepositioning Concept prior to BIG LIFT."[1]

In brief, an analysis was made of the cost-effectiveness of utilizing a civilian labor group to maintain the prepositioned fleet. Utilization of such a group promises an acceptable state of readiness plus release of scarce military spaces. Fewer civilian personnel would be required to do the same job and the total cost of prepositioning would be lowered, with, however, a modest increase in gold outflow.

The facilities were also discussed in the earlier report and improvements are being made—but slowly. More covered shop space and bays have been assigned to the custodial units, but for the most part facilities remain in various degrees of inadequacy. Funds for the improvement of the prepositioning sites have been requested.

CURRENT ORGANIZATION AND WORKLOAD

On 1 Apr 64 the maintenance groups were consolidated into one TD and renamed the ARG. The strength remained at about the same level, but overhead was reduced from 37 to 17 percent, drivers were practically eliminated, and the mechanic structure was strengthened. Table 21 gives an analysis of the functional characteristics of the new organization. The maintenance direct labor is now 68 percent of the total strength and warehousing labor is now about 16 percent.

Personnel allocation by unit and location is shown in Table 22. As the steady state is achieved, some changes will inevitably occur to equalize workloads at the several installations. According to the approximate location of vehicles on 1 Apr 64, the installation ratio of mechanic to WVE varies from 1:6 to 1:16 with an overall ratio of 1:12. Prior to reorganization and increase

TABLE 21

Analysis of Personnel Apportionment in ARG

a. Functional Distribution, Number

Category	Function		
	Overhead	Maintenance	Supply
General	275	–	223
Ordnance	–	–	35
Vehicular	11	1019	–
Artillery and armament	12	35	–
Signal	10	207	11
Engineer	5	83	13
Transportation	–	8	3
Chemical	–	6	3
QM	–	2	3
Medical	–	1	2
Supply	30	–	–
Total	343	1361	293
Percent of personnel	17.2	68.1	14.7

b. Functional Distribution, Percent

Technicians	Distribution, %
Wheeled vehicles	34
Tracked vehicles	17
Artillery and armament	2
Engineer equipment	4
Communication	10
Warehousing	16
Overhead	17

in the number of vehicles the ratio was 1:11.5.[1] The reorganization has thus kept pace with the new workload. The 1:12 ratio is to be compared with the ratio of 1:6 for organizational mechanics in active units.[20]

A new group standing operating procedure (SOP), published 1 Apr 64,[21] brought all previous procedures up to date. Implementing instructions containing a list of Technical Service support units[22] and preservation procedures[23] (see App C) were also provided.

The new maintenance procedure calls for about 40 m-hr/wheeled vehicle (including trailer) and about 70 m-hr/tracked vehicle during each S. For these values the utilization of potential index (UPI)[1] is computed as follows:

40 m-hr/wheeled vehicle and trailer × 6465 wheeled vehicles = 258,600 m-hr
70 m-hr/tracked vehicle × 1749 tracked vehicles = 122,430 m-hr
Total 6 months' m-hr demand = 381,030 m-hr,
or 63,505 m-hr per month;

1019 mechanics × 105 m-hr MOS time per month[1] = 106,995 m-hr available;

$$\frac{63{,}505}{106{,}995} = 0.59 \text{ UPI.}$$

TABLE 22

Distribution of Personnel by Unit and Location, 1

Unit	Nonsupply											
	General supervision and OH	Vehicle mechanics	Mechanics, OH	Artillery and armament mechanics	Artillery and armament, OH	Signal mechanics	Signal mechanics, OH	Engineer mechanics	Engineer, OH	Chemical techni-cians	QM techni-cians	Transport techni-cians
Command section	56	—	9	—	3	—	5	—	4	6	2	8
1st Maint Bn, Infantry	12	—	—	—	1	—	—	—	—	—	—	—
Infantry A	2	9	—	—	—	3	—	1	—	—	—	—
B	2	9	—	—	—	3	—	1	—	—	—	—
C	2	9	—	—	—	3	—	1	—	—	—	—
D	2	9	—	—	—	3	—	1	—	—	—	—
Infantry E	2	9	—	—	—	3	—	1	—	—	—	—
Hqs	2	14	—	—	—	3	—	—	—	—	—	—
Signal	2	11	—	—	—	25	1	1	—	—	—	—
2d Maint Bn, Infantry	11	—	—	—	1	—	—	—	—	—	—	—
Artillery A	2	17	—	1	—	3	—	—	—	—	—	—
B	2	17	—	1	—	3	—	—	—	—	—	—
C	2	17	—	1	—	3	—	—	—	—	—	—
D	2	16	—	1	—	3	—	—	—	—	—	—
Artillery E	2	22	—	3	—	5	—	—	—	—	—	—
Engineer	2	24	—	1	—	4	—	19	1	—	—	—
3d Maint Bn, Infantry	20	—	—	—	1	—	—	—	—	—	—	—
Tank A	2	28	—	1	—	4	—	1	—	—	—	—
Tank B	2	28	—	1	—	4	—	1	—	—	—	—
Cavalry	2	27	—	1	—	4	—	1	—	—	—	—
Mechanics A	2	24	—	1	—	4	—	1	—	—	—	—
Mechanics B	2	24	—	1	—	4	—	1	—	—	—	—
4th Maint Bn	11	—	—	—	1	—	—	—	—	—	—	—
Transport, CS	3	19	1	—	1	2	—	—	—	—	—	—
Tank, CS	2	18	—	—	—	5	—	—	—	—	—	—
Maint, Infantry	2	23	—	—	—	2	—	—	—	—	—	—
Artillery A, CS	2	10	—	—	—	3	—	—	—	—	—	—
Artillery B, CS	2	10	—	—	—	3	—	—	—	—	—	—
Artillery C, CS	3	13	1	2	—	3	—	—	—	—	—	—
Supply and Transport, Infantry	2	22	—	—	—	—	1	—	—	—	—	—
Medical, Infantry	2	11	—	—	—	—	1	—	—	—	—	—
5th Maint Bn	11	—	—	—	1	—	—	—	—	—	—	—
Engineer A, CS	2	18	—	1	—	3	—	10	—	—	—	—
Engineer B, CS	2	18	—	1	—	3	—	10	—	—	—	—
Mechanics C, Armored	2	30	—	1	—	5	—	1	—	—	—	—
Mechanics D, Armored	2	24	—	1	—	4	—	1	—	—	—	—
Signal, Armored	2	22	—	—	—	21	—	1	—	—	—	—
Engineer, Armored	3	28	—	1	—	5	—	21	—	—	—	—
6th Maint Bn, Armored	12	—	—	—	1	—	—	—	—	—	—	—
Maintenance	2	42	—	—	—	3	—	1	—	—	—	—
Tank E	2	36	—	1	—	6	—	1	—	—	—	—
Cavalry	2	27	—	1	—	4	—	1	—	—	—	—
Mechanics A	2	24	—	1	—	4	—	1	—	—	—	—
Mechanics B	2	24	—	1	—	4	—	1	—	—	—	—
Tank D	2	35	—	1	—	6	—	1	—	—	—	—
7th Maint Bn, Armored	18	—	—	—	1	—	—	—	—	—	—	—
Tank A	2	35	—	1	—	6	—	1	—	—	—	—
Tank B	2	28	—	1	—	4	—	1	—	—	—	—
Tank C	2	28	—	1	—	4	—	1	—	—	—	—
8th Maint Bn, Armored	13	—	—	—	1	—	—	—	—	—	—	—
Artillery A	2	26	—	1	—	5	—	—	—	—	—	—
B	2	18	—	1	—	4	—	—	—	—	—	—
C	2	18	—	1	—	4	—	—	—	—	—	—
D	2	19	—	2	—	3	—	—	—	—	—	—
Artillery E	2	12	—	—	—	—	1	—	—	—	—	—
9th Maint Bn, Armored	8	—	—	1	—	—	—	—	—	—	—	—
Administration	2	13	—	—	—	2	—	—	—	—	—	—
Aviation	2	13	—	1	—	1	—	—	—	—	—	—
Supply and Transport	2	24	—	—	—	2	—	—	—	—	—	—
Medical	2	17	—	—	—	2	—	—	—	—	—	—
Total	275	1019	11	35	12	207	10	83	5	6	2	8

TABLE 22

Distribution of Personnel by Unit and Location, 1 Apr 64

Nonsupply								Supply									Warehouse personnel	Total, excluding warehouse personnel	Location
…nal …anics	Signal mechanics, OH	Engineer mechanics	Engineer, OH	Chemical technicians	QM technicians	Transport technicians	Medical technicians	General	Ordnance	Signal	Engineer	Chemical	QM	Transport	Medical	OH			
—	5	—	4	6	2	8	1	—	—	—	—	3	2	—	—	—	—	99	Mannheim area
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	16	
3	—	1	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	18	
3	—	1	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	18	
3	—	1	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	18	
3	—	1	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	18	
3	—	1	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	18	
3	—	—	—	—	—	—	—	3	1	—	—	—	—	—	—	1	3	24	
25	1	1	—	—	—	—	—	—	—	4	—	—	—	—	—	—	10	44	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	15	Karlsruhe area
3	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	5	28	
3	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	5	28	
3	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	5	28	
3	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	6	28	
5	—	—	—	—	—	—	—	6	1	—	—	—	—	1	—	1	7	41	
4	—	19	1	—	—	—	—	3	1	—	3	—	—	—	—	—	—	58	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	24	
4	—	1	—	—	—	—	—	5	1	—	—	—	—	—	—	—	6	42	
4	—	1	—	—	—	—	—	5	1	—	—	—	—	—	—	—	6	42	
4	—	1	—	—	—	—	—	8	—	—	—	—	—	1	—	—	11	44	
4	—	1	—	—	—	—	—	7	—	—	—	—	—	—	—	—	9	39	
4	—	1	—	—	—	—	—	7	—	—	—	—	—	—	—	—	9	39	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	15	Mannheim area
2	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	29	
5	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	2	28	
2	—	—	—	—	—	—	—	7	4	1	2	—	—	—	—	—	13	41	
3	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	2	17	
3	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	2	17	
3	—	—	—	—	—	—	—	7	1	—	—	—	—	—	—	—	6	30	
—	1	—	—	—	—	—	—	3	1	—	—	—	—	—	—	—	3	29	
—	1	—	—	—	—	—	—	2	—	—	—	—	—	—	1	—	3	17	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	15	Pirmasens area
3	—	10	—	—	—	—	—	3	—	—	2	—	—	—	—	—	11	39	
3	—	10	—	—	—	—	—	3	—	—	2	—	—	—	—	—	11	39	
5	—	1	—	—	—	—	—	8	1	—	—	—	—	—	—	—	10	48	
4	—	1	—	—	—	—	—	7	—	—	—	—	—	—	—	—	9	39	
21	—	1	—	—	—	—	—	5	1	5	—	—	—	—	—	—	12	58	
5	—	21	—	—	—	—	—	4	1	—	2	—	—	—	—	—	15	65	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	16	Kaiserslautern area
3	—	1	—	—	—	—	—	13	4	1	1	—	—	—	—	—	19	67	
6	—	1	—	—	—	—	—	6	—	—	—	—	—	—	—	1	8	53	
4	—	1	—	—	—	—	—	8	—	—	—	—	—	1	—	—	11	44	
4	—	1	—	—	—	—	—	7	—	—	—	—	—	—	—	—	9	39	
4	—	1	—	—	—	—	—	7	—	—	—	—	—	—	—	—	9	39	
6	—	1	—	—	—	—	—	6	1	—	—	—	—	—	—	—	8	52	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	22	Germersheim area
6	—	1	—	—	—	—	—	6	1	—	—	—	—	—	—	—	8	52	
4	—	1	—	—	—	—	—	5	1	—	—	—	—	—	—	—	6	42	
[illegible]	—	1	—	—	—	—	—	5	1	—	—	—	—	—	—	—	6	42	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	17	Kaiserslautern area
5	—	—	—	—	—	—	—	5	1	—	—	—	—	—	—	—	6	40	
4	—	—	—	—	—	—	—	3	1	—	—	—	—	—	—	—	4	29	
4	—	—	—	—	—	—	—	3	1	—	—	—	—	—	—	—	4	29	
3	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	3	39	
—	1	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	3	18	
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	12	Idar-Oberstein area
2	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	2	19	
[illegible]	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	4	20	
[illegible]	[illegible]	—	—	—	—	—	—	3	1	—	1	—	1	—	—	—	5	34	
[illegible]	—	—	—	—	—	—	—	4	1	—	—	—	—	—	1	—	5	27	
[illegible]	10	83	5	6	2	8	1	223	35	11	13	3	3	3	2	30	301	1997	

This is considered comparable to the UPI of typical military units. It applies only to the steady state at the above maintenance levels. Fluctuations due to exchanges, future exercises, etc., are not accounted for. It is suggested that the workload be checked at 6-month intervals to ascertain if the man-hour demand remains constant.

The Department of the Army has approved substitution of more modern vehicles for about 60 percent of the prepositioned stock, and it cannot be ascertained, as of this writing, what the overall condition of the new vehicles will be or the maintenance effort and parts that will be required to achieve an RFI configuration. The ¼-ton M38 will be replaced by the M151 (more than 2000), the 2½-ton M34 will be replaced by the M35 (more than 1000), the M59 APC will be replaced by the newer M113 (more than 1200), and the M48A1 tanks by the M60 (more than 800).

If the new equipment is not in good order, the S time must increase. If it is in good order, S time, under present plans, will remain roughly the same as it is now. Reception, inventory, warehousing, turn-in of excess repair parts, and requisition of new parts will be superimposed on the existing workload.

RESOURCE-DEMAND ESTIMATES

The support required from Seventh Army Support Command during BIG LIFT, according to the V Corps after-action report,[18] is given in Table 23.

Ordnance

Most of the man-hours reported were spent in third-echelon repairs and TIs during the period 8 Jul–22 Oct 63 in preparation for the exercise. Existing Ordnance units assumed the support role of the 2d Armd Div's maintenance battalion during the marches and third-echelon backup of this maintenance battalion during the FTX. Additional time was spent in ammo handling on issue and turn-in. A major effort was needed to fill the division ASL/AOSL and in other supply actions. In the same conditions, if two divisions had been deployed the Ordnance workload would have been close to 2,000,000 m-hr in the same period. As it was, Ordnance support of active units was severely curtailed, and it is estimated that it would have been impossible to comply with this manpower demand.

The new maintenance procedure promises to alleviate the amount of concentrated effort required during hasty preparation. If by the S and orderly repair process the vehicles can be maintained in an RFI posture, the ASL/AOSL is maintained at or near 100 percent fill, and the divisional maintenance battalions are airlifted early and are mission-ready when the bulk of the divisions arrive, then it appears that Ordnance support requirements will be reduced to an acceptable minimum. Ordnance units now in direct support of the prepositioned equipment should be sufficient for support until the entire division slices are constituted, provided the equipment is maintained RFI.

TABLE 23

Technical Service Support during BIG LIFT

Service	Strength	Man-hours	Duties
Ordnance	1000	916,000	TI, third-echelon, issue, preparation, ammo handling
Transportation	600	699,000	Transportation of troops and baggage, movement control
Engineer	1800	120,000	Construction, dismantling, water points, power supply, testing, issue, and third-echelon
Signal	700	166,800	Installation and operation of communications, TI, third-echelon
Chemical	260	10,000	Issue, third-echelon, and turn-in
Medical	300	42,000	Hospital service, evacuation, issue, third-echelon, sanitation
Quartermaster	1000	303,000	Hot meals, baggage handling, distribution points, issue, TI, third-echelon, bath, laundry, POL
Aviation (transportation)	na	4,500	Preparation and movement of aircraft
Military Police	na	102,650	Traffic control and police duty
Labor Service units	240	146,000	Guard duty and general labor
Total	—	2,509,950	—

Transportation

The bulk of transportation effort was devoted to the movement of troops and baggage between staging areas and airfields. The Transportation Officer, Seventh Army, points out that the amount of support furnished was more than that necessary even under the accelerated arrival scheduling. Since it is not likely that the two divisions would arrive simultaneously, the demand for transport could conceivably be met but with some expense to other theater units. Movement-control effort was increased during the entire maneuver and would be very much more increased if all units were moving, for example, to general alert order positions. Heavy transport equipment was required during the FTX for evacuation of vehicles.

The early arrival of the combat support transportation battalion personnel would reduce transportation support requirements, particularly if the airlift scheduling was extended. The expected increase in movement-control effort can be met by current planning. However, when the action starts, the control group is apt to be overloaded. The prepositioning of the equipment of the necessary number of movement-control teams, later to become part of the division slice, would help in alleviating the situation that could be expected at that time. The team's personnel could then be airlifted with the divisions.

Engineer

One former mission of the ARG, preparation and operation of the staging areas, has been assigned to the Engineers. Some preparatory effort was necessary in testing engineer generators and related equipment and in the requisitioning and issuing of engineer supply. During the maneuver the establishment of water points and power sources was an engineer function, as was third-echelon backup of the engineer battalion. The arrival of two divisions would have acted to double the engineer support requirements.

Even the early arrival of slice elements of the Corps of Engineers would not relieve theater engineers of the preparatory mission, which would double manpower demand by the arrival of two divisions. Because of the possible necessity for dispersion no work is feasible until commitment; apparently this situation cannot be relieved. However, the remainder of the engineer support requirements could probably be met by prepositioning the equipment of engineer utilities teams, water-purification teams, or water-supply companies of the division slices and airlifting the troops in the advance party of the divisions.

Signal

A large part of the signal operational effort in BIG LIFT was extraneous to the actual action and quite unrealistic, but the realistic requirements were still huge. Most of these requirements were preparatory in nature and accomplished before deployment (e.g., the erection of lines, installation of instruments). The third-echelon maintenance workload was comparatively small during the preparatory phase, but the reconstitution of signal stores required a sizable supply effort.

Apparently, because of the area type of operation under which the Signal Corps works, augmentation of existing units with construction and installation teams, control teams, and headquarters operations teams is a feasible solution to the signal support problem. The determination of the types of units that are to be eventually part of the regular division slices would require study. In whatever form, the prepositioning of the equipment of these units and the early airlift of the personnel, with appropriate planning for absorption, should tend to reduce the communications problem at the time when it would become most acute.

Chemical

The chemical problem in BIG LIFT was not severe and was readily solved. Turn-in would be eliminated and the workload would be about the same as it was in BIG LIFT even with two divisions involved, consisting of class V issue and maintenance.

At the moment it appears that only prior planning is sufficient and that no serious problems exist.

Medical

The medical workload during BIG LIFT contained a great deal of support for the troops in support of the operation. The medical demand in a real action would have been considerably greater, but in BIG LIFT it consisted of the normal disease and nonbattle injuries. An additional effort was required in issuing medical supplies and in turn-in.

In an action with both divisions deploying, the medical workload shown for BIG LIFT could be more than doubled and would be superimposed on the demands from active units. Sanitation and preventive-medicine units would be in early demand, followed somewhat more slowly by bed demand. Some increase in backup might be necessary in the communications zone. Prepositioning of the equipment of selected slice units and arrival of troops with the division would act to lower the medical workload on existing units and permit more allocation of their effort to the units that they now support.

Quartermaster

A part of the quartermaster (QM) effort was in service to departing troops—an unrealism—but even at that, with two divisions deploying, the quartermaster workload could increase to over 500,000 m-hr in the first 15 days. Since it can be expected that a majority of theater elements would take the field at the same time as the two divisions, the normal workload of some QM units would increase to the point that very little support could be given the incoming troops.

The QM activities are so many that a detailed study is needed of the slice elements to be phased in in support of the two divisions. Additional bath and laundry units are obviously needed, as well as refrigeration, bakery, POL, and subsistence supply units. The prepositioned equipment of the selected units would permit the troops to be phased in with the advance party and the main body so that the excess demand on QM would be reduced and other theater units would not be deprived of support.

Aviation

The workload on this segment consisted principally of transfer and return of aircraft already in use. None of this equipment was prepositioned. In an active situation the aircraft would have to be reapportioned and the action taken would be very similar to that in BIG LIFT.

Only reallocation planning seems to be indicated.

Military Police

The military police workload was realistic enough except that it was concentrated in the maneuver area and the routes to and from that area. The deployment of two divisions instead of one would hardly be likely to increase the workload beyond the capabilities of the existing units.

Apparently, no action is indicated.

Labor Service Units

These units were used for guard duty and general labor. In a war situation, these units would not exist in their present form, if at all. If available and trustworthy, they could probably be used for the same type of duty.

No action is indicated.

Recapitulation

The excessive demand for support during BIG LIFT raised the question of the amount of support that could be furnished by Seventh Army to two divisions deploying during a period of tension, even after the start of hostilities. After removing the identifiable unrealism from the operation, indications were still very strong that not even minimal support requirements could be met except by endangering resident theater units, and that some requirements could not possibly be met.

One possible solution to this problem is the prepositioning of the equipment of selected slice elements, together with appropriate supply stockage, and phased-in airlift of the personnel. From after-action reports the need for certain units becomes more or less apparent.

PREPOSITIONING IN SEVENTH ARMY

Concepts

The original concept of prepositioning and its initial implementation were based on rapid response (rapid reaction time) after the outbreak of hostilities. The TOE of a two-division force was to be maintained RFI and the force was to be deployed in no more than 14 days, i.e., be airlifted into the theater, pick up their equipment, and take the field.[24,25]

As planning proceeded for Operation BIG LIFT, the mounting demand for support was such that the capability to furnish it after hostilities had commenced appeared unlikely. BIG LIFT was therefore conducted under the premise that a "period of tension" existed. In the after-action critique[26] the Commander in Chief, US Army, Europe (CINCUSAREUR) announced that 90,000 men—75,000 in 30 days—would have to be deployed for support in addition to the divisions. The concept was thus revised to the extent that it was considered infeasible as a posthostilities action.

Currently the demand by resident units for military spaces brought up consideration of reducing the custodial force by reducing the maintenance level and utilizing the mechanics of the two divisions to assist in preparing the equipment. The advance party and technicians would be airlifted early—the main body within 20 days—and the force planned to take the field at about D+45. The Seventh Army presented its position to USAREUR on the matter and at this writing no decision had yet been made.

Deployment

In BIG LIFT the main body of the 2d Armd Div was airlifted into the theater in less than 3 days. The advance party had arrived earlier. Given the same numbers of aircraft it is indicated that the main bodies of the two divisions could be deployed in 6 days—hardly less. If the equipment is RFI the unit marry-up could be completed in 3 days or less, but the support required prior to taking the field is impracticably—if not impossibly—high. If the equipment is not RFI—which promises to be the case if the ARG is reduced—preparation time would be long even if Technical Service support was available. In BIG LIFT, vehicle preparation started 8 July and was ostensibly completed 102 days later. For two divisions this would extrapolate to about 200 days, since it is inconceivable that more theater Ordnance support could be furnished.

The maintenance battalions and the organizational mechanics and drivers of the divisions could be used to augment the preparatory effort if they were part of an advance party. However, unless the ARG are supplied tools under a TA, the organizational mechanics would merely substitute for the ARG. This emphasizes the fact that TA tools for something over 1000 mechanics is a vital element in shortening the make-ready time.

If the equipment is not RFI, deploying the line elements of the divisions until a rapid marry-up is assured seems relatively pointless, whether pre-hostility or posthostility. BIG LIFT demonstrated that the force could be air-lifted expeditiously; but, given a long preparatory period, sealift begins to look attractive. Assembling the necessary shipping, refitting as troop carriers, loading, and crossing will require time. The only apparent advantage offered by prepositioning in this case is that there is little demand on freighter-type vessels and port facilities at either end. This is a simplification of the vast problem of sea deployment and staging, but it illustrates the point.

If the response is not rapid, the military advantages of prepositioning would tend to disappear. As the time required for airlift and deployment as an effective force approaches that required for sealift and similar deployment, prepositioning becomes less and less attractive.

It would appear that the concept of prepositioning possesses most merit when the reaction is most rapid and gradually loses its inherent advantages as the reaction becomes slower. It can never quite lose all its effectiveness because the materiel is always available for issue to allied troop units or as a buildup of theater reserve. The other influencing conditions that must be met are discussed in the following sections.

Vulnerability

It can be presumed that the prepositioning sites are known to a potential enemy and that at some point in time the target would be most lucrative. In BIG LIFT this point was the marry-up phase, when men and materiel were together. Clearly the profitability of the targets can be reduced by dispersion of the equipment into, say, company-sized units. The staging locations would have to be predesignated, with plans prepared for acquisition and preparation and the equipment dispersed just prior to overt hostile action. Vulnerability of the concept caused by interdiction of the movement into the theater, whether by sea or by air, is beyond the scope of this study.

Accepting dispersion as a solution, the problem becomes one of moving the vehicles to the dispersal areas. If the equipment is RFI the ARG personnel could move the equipment in no more than 6 trips/person. Augmentation by a rear-area unit for this movement would shorten the dispersal time. If the equipment is not RFI and some vehicles require towing, either a longer time is necessary or even more support is required.

If the vehicles must remain in a staging area awaiting repair the chance of acquiring the site as a target increases each day. Furthermore the demand for parts would generate a demand for premium line-of-communication space.

It can be concluded that, discounting a sudden attack, the equipment on the whole is less vulnerable to destruction if the vehicles are RFI and can be dispersed promptly.

Condition of the Equipment

Although much of the stored equipment was RFI, the condition of the vehicles was such that repair and make-ready took more than 3 months, even with more than 100 percent augmentation of the then AMG, and the expenditure of over 600,000 m-hr by supporting Ordnance units. If the initial alert had been delayed, BIG LIFT could very well have failed.

As a result of this situation the maintenance procedure in ARG has been revised so that no vehicle will be in storage longer than 6 months without a complete S and necessary repairs (although AR 700-28[8] prescribes 12-month periods). Thus the fleet will average 3 months in operation, depending on adequate parts supply. The latter presumes adequate requisitioning and fill.

Reduction of effort—by reducing manning—extends the cycle, reduces the level of maintenance, or creates a periodic backlog that must be taken care of by periodic or sporadic augmentation. The first two alternatives may result in a fleet that is something less than RFI, with accumulating deterioration. The last alternative is not logically sound, since there is no real saving of manpower. A reduction of effort results in a lower parts issue in the steady state, but the requirements for parts to make the fleet RFI would be expected to remain the same, i.e., although parts would be issued at a reduced rate, the surge generated by the need for rapid preparation would tend to equalize demand. This means that parts stockage in depots or in the working ASL/AOSL would gradually increase as the state of preparedness remains at the acceptable level.

If the ASL/AOSL must be used in the preparatory phase because of reduced stockage, then the force takes the field with less than the planned repair capability. The effectiveness of the force is consequently subject to rapid deterioration as vehicles break down and mobility is lost.

Performance of the Vehicular Fleet

The prepositioned vehicles of the same models now in the hands of theater troops performed as well as or better than those in the hands of active units. However, this situation occurred only after quite an extensive preparatory effort.

The standard B vehicles (M38A1, M59, and M48) did not perform as well as their more modern counterparts in the 3d Armd Div. It appears that a combination of factors, beginning with the original poor condition of the vehicles, tended to reduce the level of performance displayed at the start of the exercise very rapidly. The vehicles performed satisfactorily during the first part of the exercise but began to fail increasingly at the end. This became apparent only after the restorage phase was examined.

In view of the above performance it is concluded that if the vehicles in prepositioned storage are of the latest type, and if they are kept in RFI condition, they can be expected to perform as well as or better than those in active units. Rotation of current vehicular equipment through prepositioning would tend to keep all equipment of this type at nearly the same level of reliability.

Prepositioned Support

The support requirements placed on Seventh Army during BIG LIFT have been discussed earlier. BIG LIFT demonstrated that the response time could be very rapid if the materiel is combat ready, but it also demonstrated that an effective force could be built up only by degrading normal support to resident units. One solution appears to lie in prepositioning the equipment of urgently needed nondivisional support elements—later to become part of the division slices. Manpower for these units would be airlifted early and at the appropriate times. The lesser demand on Seventh Army during the initial stages of deployment points to a potentially higher degree of success of the prepositioning concept while an effective combat posture is maintained. In any event, the experiences of BIG LIFT indicate the advisability of prepositioning some support elements and a study of their type and quantity is strongly indicated.

Disposition of Personnel

The present plan for disposition of ARG personnel after issue of the prepositioned equipment is quite general and could create problems at a time when such additional problems would not be welcome. It is pointed out that the ARG will become, if it is not already, a pool of technicians undergoing individual training comparing very favorably to that furnished in TOE units. Although they are not training as a wartime unit, absorption of technicians into a unit is usually accomplished expeditiously. Recognition of the MOS status of these individuals and the establishment of tentative wartime assignments are considered part of efficient management and would do much to relieve any remaining morale problems.

ALTERNATIVE COURSES OF ACTION

Prepositioning is, primarily, a device for using limited manpower to the best advantage. If its powerful military attributes are ignored, from the standpoint of everyday economics it is wasteful of materiel resources. The prepositioned materiel is always threatened by obsolescence, deterioration, or destruction, even if it is never used. However, the same process of reasoning that justifies the existence of a standing army or any emergency unit can be applied just as forcibly to prepositioning. The value criterion that applies is that of readiness to meet the emergency for which the equipment is designed.

The recently announced policy for the storage of prepositioned reserve equipment states that "controlled humidity storage (CH) is the preferred type of storage space for storing prepositioned equipment."[8] Evaluation of the efficacy of such storage is beyond the scope of this study. In the following discussion of alternative courses of action, this type of storage is included in either the first or second alternative, as applicable. The policy is obviously predicated on a reduction in manpower and a slower deterioration rate of the stored equipment. Balanced against this is the cost of such warehouses, increased vulnerability to hostile action, and the possibility of a lower state of availability and readiness. In the application of this policy the maintenance procedure will be modified also. AR 700-28[8] prescribes a quarterly visual inspection, a periodic sample check, and a complete physical inspection and test every 3 years (every year for items not in CH). Experience indicates (a) a possible risk that these periods may be too long and (b) that the optimal length of the period remains to be determined. If consideration of CH is included, three major alternative courses of action emerge. Discussion of some advantages and disadvantages of each approach follows.

Maintenance of Prepositioned Equipment at Theater Standard

Advantages. The advantages gained are: (a) assurance of rapid and flexible response to an emergency, (b) low vulnerability because of capability for rapid dispersal, (c) low demand on critical shipping in emergency, (d) high deterrent potential because of high state of readiness, (e) promise of high reliability in action, (f) availability of trained technical pool for immediate reassignment after issue of the equipment, (g) possibility of use of civilians in lieu of military personnel, and (h) potential for use by other than deployed units.

Disadvantages. Disadvantages to be considered are: (a) high materiel cost for initial stockage and upkeep, (b) required prepositioning of selected support elements for combat effectiveness, (c) degradation of peacetime strength of resident units because of levies to form the custodial group, (d) additional real estate and facility costs for storage and maintenance when prepositioning slice elements are included, (e) moderate increase in the gold outflow with use of indigenous personnel, and (f) high demand for air transport.

Storage at Less than RFI Configuration

Advantages. The advantages gained are: (a) reduction in requirements for manpower in the custodial group and consequent strengthening of resident units, (b) possibility of using sea or air for lift of the main body, (c) deterrent potential occasioned simply by existence of the stored materiel, (d) possibility of slower and more extended scheduling of troop phase-in, and (e) possibility of use of the mechanics of the deploying units to restore the equipment during a period of tension.

Disadvantages. Disadvantages to be considered are: (a) slow response to emergency, (b) vulnerability to destruction because of low dispersal capability, (c) postponement rather than reduction in overall parts demand, (d) absence of reduction in cost of initial stockage, (e) increased likelihood for a short period of hostilities, (f) considerable support demands on Seventh Army in the preparatory phase, and (g) necessity of possession of TA tools in the preparatory phase.

Discontinuance of Prepositioning

Advantages. Advantages gained are savings on: (a) manpower, as resident units reacquire personnel; (b) materiel, as equipment is placed in depot storage and parts requirements therefore decline; and (c) real estate and facility costs. A further advantage is that reinforcement can be accomplished if the period of tension is of sufficient length.

Disadvantages. Disadvantages to be considered are: (a) loss of the deterrent potential of the prepositioned equipment, (b) need for exclusive reliance on sealift for equipment augmentation, (c) requirement that containment of aggression be met by the current five-division force unless the period of tension is long, and (d) possibility of DA absorption of some of the manpower spaces now allotted to the custodial group.

Discussion

Implementation of prepositioning was such that it never acquired its maximum potential. BIG LIFT showed the existence of an inherent response lag of about 3 months, and the divisions were completely dependent on Seventh Army for support. Adequate maintenance is necessary to remove the first obstacle; prepositioned support should alleviate the second. Although realization of the full potential of prepositioning may be impracticable, a respectable level is attainable.

Austerity will govern allotment of resources to the theater in peacetime. Reallotment of these resources within the theater determines the final defense posture of the Army.

With prepositioned equipment in a state of readiness, the capability of building up a seven-division force within a short period is at its highest. Degradation of this state of readiness reduces the capability accordingly. Removal of a comparative handful of military spaces from the custodial group will initiate this degradation; it is not likely that these same spaces spread through the Army will raise the readiness of Seventh Army sufficiently to overcome the longer response time of the two CONUS divisions.

Degradation will progress and eventually approach a backlog so great that the time required for its elimination would be enough for deployment of the two divisions by sea.

In the long range, therefore, only two alternatives appear feasible: (a) a seven-division force with the prepositioned divisions receiving the same relative support as the resident divisions; or (b) a five-division force for containment until reinforcement can arrive from CONUS, with prepositioning eliminated, spaces distributed, and equipment placed in depot storage as a theater reserve. The former course appears to offer a greater prospective payoff; specifically, full implementation of the concept should require the following:

(a) Maintenance of all equipment in an RFI condition.

(b) ASL/AOSL sufficiently complete for the critical period (until normal support is established and the division slice is formed).

(c) Prepositioning of the equipment of selected slice elements.

(d) Early airlift of the personnel of maintenance and transportation battalions and selected slice elements.

(e) Airlift scheduling matching response time desired and as the situation permits.

(f) Movement-control plans incorporating movement of prepositioned vehicles.

(g) Augmentation of the ARG commensurate with the increased workload.

(h) Periodic checks of random vehicles to check the level of maintenance and to determine the appropriate interval between S inspections for the prepositioned equipment.

APPENDIXES

Appendix A

ORGANIZATION FOR DATA COLLECTION

Levies were placed by Seventh Army on the Support Command, VII Corps, and the 32d Brigade for officers and enlisted men to form the data-collection teams. These teams were organized as shown in Fig. A1.

Seven battalions from the 2d Armd Div and seven similar battalions from the 3d Armd Div were selected as samples for detailed study. Fourteen teams were assigned and remained with the vehicular equipment of these units in the field from preexercise phase until turn-in and final inspection. The remaining teams were used to man command posts, maintain daily communication, collect data from supporting Ordnance units and the control centers, handle administrative matters, and to assist two especially assigned RAC analysts from CONUS in reducing the masses of data being received. The original study team, consisting of two RAC analysts, directed the day-to-day accumulation of data.

In the expectation of attrition of the original sample size through many causes beyond the control of the teams, the data collection was started on a rather large sample. This attrition actually took place. For example, E Co, 124 Maint Bn, was stationed at the Stars and Stripes airfield (used as the divisional airfield by 2d Armd Div, and could not be observed by the collection team; the Forms 2404 (used as a maintenance worksheet for TIs and periodic inspections) made out during the preparatory phase could not be found for several units; and in the restorage phase, when vehicles were being prepared for LONG THRUST exercises, the records went with the vehicles into the field and were retrievable only at a date later than the date of this report.

The original sample size and the divisional units sampled are shown in Table A1.

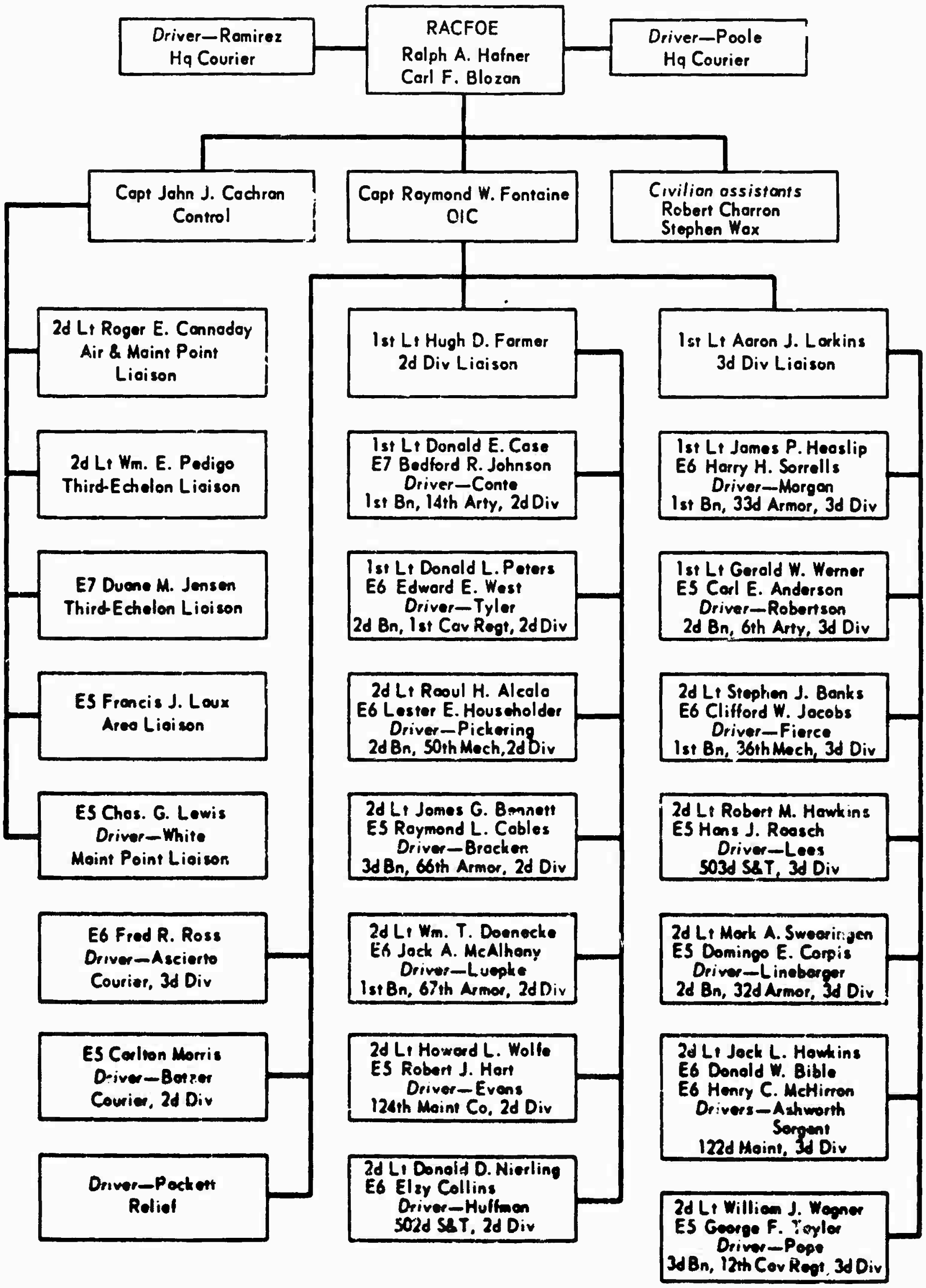


Fig. A1—Manning Chart, Data-Collection Teams

TABLE A1

Composition of Divisional Units in Total Sample

a. Numbers

Unit	Wheeled vehicles						Tracked vehicles				Total
	¼-ton[a]	M37 ¾-ton	M34, M35 2½-ton	M52, M54 5-ton	10-ton	Total	Tanks and VTR[b]	APC[c]	M52, M44, M55 SP howitzer	Total	
2d Armd Div (Excluding IMG Vehicles)											
2d Bn, 1st Cav Regt	74	12	24	15	0	125	29	40	0	69	194
2d Bn, 50th Mech	43	20	15	11	0	89	7	14	0	21	110
1st Bn, 14th Arty	30	28	20	17	0	95	2	11	18	31	126
1st Bn, 67 Tk	39	10	25	19	0	93	60	24	0	84	177
3d Bn, 66 Tk	33	9	17	21	0	80	61	24	0	85	165
124 Maint	24	26	177	24	5	256	3	0	0	3	259
502 S&T	16	16	89	38	0	159	0	0	0	0	159
3d Armd Div											
3d Bn, 12th Cav Regt	74	13	35	[illegible]	0	143	29	42	0	71	214
1st Bn, 36th Mech	36	19	15	13	0	83	4	69	0	73	156
2d Bn, 6th Arty	31	26	21	18	0	96	2	11	18	31	127
2d Bn, 32d Tk	37	7	21	17	0	82	60	21	0	81	163
1st Bn, 33d Tk	37	8	18	21	0	84	60	21	0	81	165
122d Maint	15	12	74	16	6	123	2	0	0	2	125
503d S&T	16	15	89	34	0	154	0	0	0	0	154

b. Summary

Unit	Wheeled vehicles						Tracked vehicles				Total
	¼-ton[a]	M37 ¾-ton	M34, M35 2½-ton	M52, M54 5-ton	10-ton	Total	Tanks and VTR[b]	APC[c]	M52, M44, M55 SP howitzer	Total	
2d Armd Div (Excluding IMG Vehicles)											
Number of vehicles in each class	259	121	367	145	5	897	162	173	18	353	1250
Percentage of total vehicles sampled	27	19	34	32	31	29	39	30	17	32	30
3d Armd Div											
Number of vehicles in each class	247	100	273	139	6	765	157	164	18	339	1104
Percentage of total vehicles sampled	25	17	31	31	38	26	33	25	24	28	27

[a] In 2d Armd Div, M38 and M170 ¼-ton vehicle. In 3d Armd Div, M151 ¼-ton.
[b] In 2d Armd Div, M48 and M88 tanks and VTR. In 3d Armd Div, M60 and M88 tanks and VTR.
[c] In 2d Armd Div, M59 and M84 APCs. In 3d Armd Div, M113 APCs.

Appendix B

COMPUTATION OF PERIOD RELIABILITY

According to the exponential failure law, items fail at a rate proportional to the number of survivors. As a result, the fraction $F(t)$ surviving at a time t is given by

$$F(t) = e^{-t/\theta} \tag{B1}$$

where $e = 2.7183\ldots$, and θ is the mean life of the item. This law covers a wide variety of items subject to failure.

If items fail according to this law, and if only the first n failures are observed, then the mean life θ is given approximately[27] by the expression

$$\theta \simeq \frac{1}{n}\left[t_1 + t_2 + \ldots + t_n + (N-n)\,t_n\right] \tag{B2}$$

where t_i is the time at which the ith failure occurred, and N is the total number of items at time zero.

Based on data acquired in BIG LIFT phases II to V, Eq B2 has been used to estimate vehicle mean life, interpreting "failure" to mean requirement for the initial third-echelon major-assembly replacement. The results, given in Table B1, cannot be compared directly for the two divisions because 2d Armd Div vehicles traveled farther, on the average, in BIG LIFT than 3d Armd Div vehicles did.

TABLE B1

Estimate of Vehicle Mean Life, by Type of Vehicle

Division	All wheeled	All tracked	APC only	Tanks and SP howitzer	Division total
	Time to initial failure,[a] days				
2d Armd	62	48	42	59	57
3d Armd	118	98	106	92	112

[a]First time third-echelon major-assembly replacement is required.

The values in Table B1 reflect the usage rates given in Table B2. Figure B1 shows two sample curves comparing the actual data from 3d Armd Div with the curve derived from the estimate of mean life. For the 14 days' operation of

TABLE B2

Estimated Miles Traveled per Month, Wheeled and Tracked Vehicles

(Based on 14 days of operation during BIG LIFT)

Division	Type of vehicle	
	Wheeled	Tracked
2d Armd	2000	1100
3d Armd	1500	750

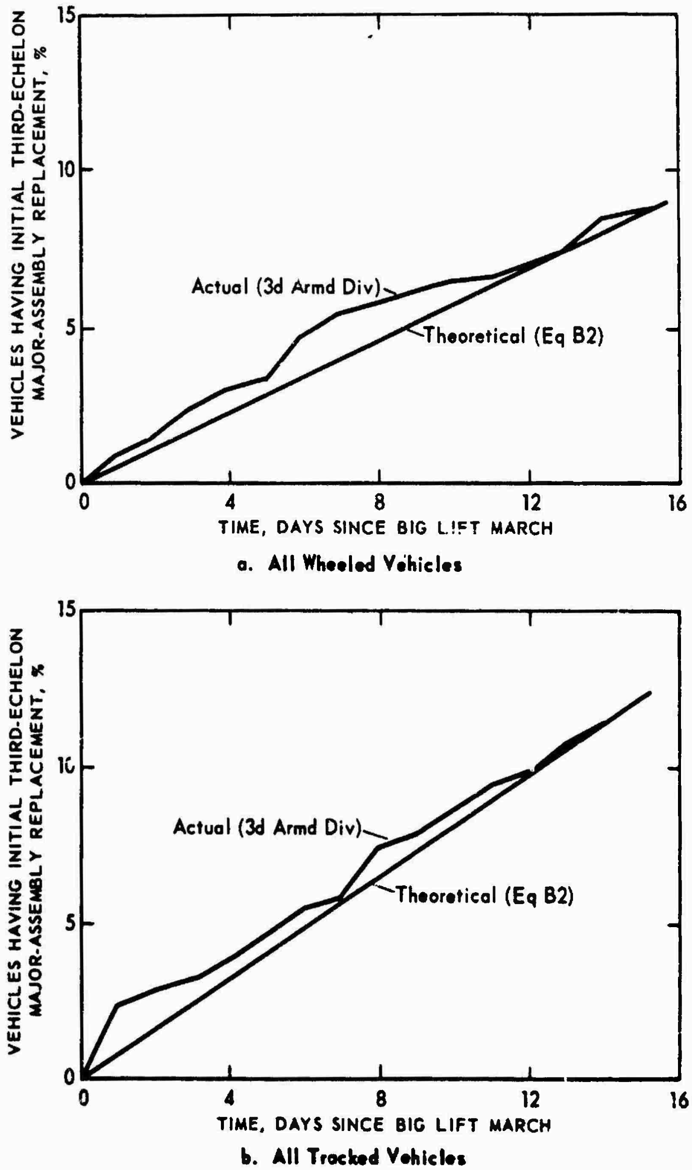


Fig. B1—Vehicle Mean Life, Comparison of Actual Data with Theoretical Curve

March is Day 1.

BIG LIFT (about 700 miles for wheeled vehicles and 350 miles for tracked vehicles) the fit is quite close, and the estimation of mean life by Eq B2 is considered satisfactory.

Because of the magnitude of the repairs on 2d Armd Div vehicles during the restorage phase a further assumption was needed. The repairs required in this phase were deferred from earlier in the maneuver and may be considered to have occurred randomly—according to the exponential distribution—during these earlier phases.

As explained in the body of this report (see the section "Maneuver Phase and Reliability"), vehicle reliability in this study is measured principally in terms of the percentage of vehicles requiring no third-echelon major-assembly replacement for 90 days. This percentage is called the "90-day reliability." Given the vehicle mean life θ, the 90-day reliability $F(90)$ can be calculated from Eq B1:

$$F(90) = e^{-(90/\theta)} \tag{B3}$$

In order to obviate problems resulting from unequal mileages in the two divisions, the 90-day reliabilities obtained through the use of Eq B3 have all been modified to reflect 90-day mileages of 3000 miles for wheeled vehicles and 1500 miles for tracked vehicles. The resulting 90-day reliabilities—which now can be compared directly for the two divisions—are given in Table B3.

TABLE B3

Percentage of Vehicles Requiring No Major-Assembly Replacement in 90 Days' Operation

(Adjusted to 3000 miles for wheeled vehicles, 1500 miles for tracked vehicles)

Division	Vehicles				
	All wheeled	All tracked	APC	Tanks and SP artillery	Division total
	Reliability, %				
2d Armd	49	44	40	48	48
3d Armd	59	52	55	48	57

Figure B2 allows for easy conversion of the values for, say, 90-day reliability for a specific usage rate to the appropriate value for another usage rate. Table B3, as well as several tables in the text, give 90-day reliability values for 1000 or 500 miles/month. When other usage rates are to be considered, the nomograph shown in Fig. B2 yields the correct value. As Fig. B2 shows, the nomograph may be used for reliability over any of the durations—30, 45, 60 days—in the text.

Figure B3 enables the conversion from, say, a 90-day reliability to a 30-day reliability. A 30-day reliability may also be converted to a 60-day reliability, using the same nomograph. An example is again included in Fig. B3.

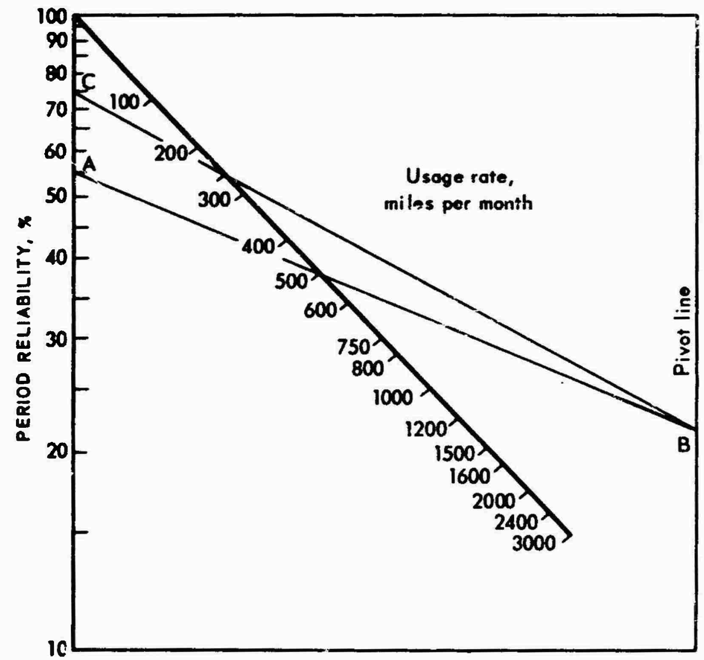


Fig. B2—Conversion of Period Reliabilities for Various Usage Rates
Period held constant.

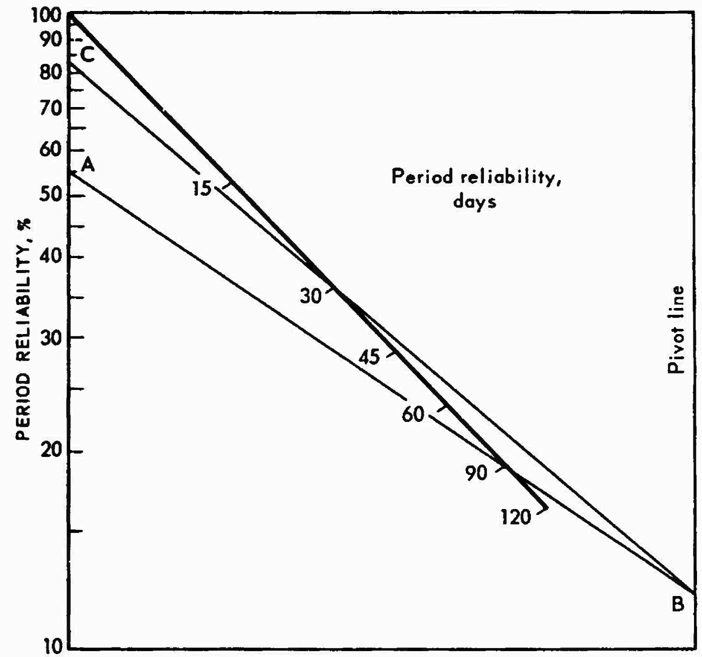


Fig. B3—Conversion of One Period Reliability to Another
Usage rate held constant.

Appendix C

EXTRACTS FROM SOP, USA COMBINED ARMS MAINTENANCE GROUP, 1 APRIL 1964[21]

ACTIVITIES PRIOR TO THE ARRIVAL OF DEPLOYING FORCES

1. GENERAL: Prior to the arrival of the deploying forces planning, coordination and tasks to be performed are enumerated as follows:

a. This Hqs will:

(1) Publish a detailed operation plan for each exercise.

(2) Arrange a planning conference with the technical services representative to coordinate necessary support for each exercise.

(3) Arrange for necessary staging areas.

(4) Maintain close liaison with all participating headquarters.

(5) Establish an operational control center and dispatch liaison teams as required.

(6) Arrange for adequate communications facilities during the exercise.

(7) Arrange necessary logistical support for the deploying force.

(8) Prepare necessary briefing charts and instructional aids as required for each exercise.

(9) Make arrangements for and receive advance party of deploying force.

b. Battalions will:

(1) Insure that all equipment authorized is on hand and ready for issue.

(2) Mount all TO&E vehicular radios.

(3) Display all equipment in such a manner as to expedite inventory.

(4) Insure that all prepositioned crew served weapons are available and ready for issue.

(5) Insure that prepositioned basic load of ammunition is available and released for issue.

(6) Prepare to receive the deploying force advance party.

2. STAGING AREAS: This headquarters makes the necessary arrangements for an appropriate staging area in the near vicinity of the prepositioned equipment storage areas. As a minimum, staging areas, when prepared for occupancy, should include necessary facilities to maintain the health, welfare and morale of the deploying forces.

3. RECEPTION OF ADVANCE PARTIES: This headquarters makes the necessary arrangements for the reception of the deploying forces advance parties and delivers them to the battalion commander responsible for issue of equipment. Battalion commanders arrange for necessary administrative and logistical support of the advance parties.

4. LOADING PLANS: Realistic loading plans will be developed for each TO&E company-sized unit of the current Armored/Infantry Division and Combat Support Battalions. These loading plans will be filed in a loose leaf binder kept readily available for reference or use.

5. MOVEMENT OF EQUIPMENT TO STAGING AREAS:

a. Prior to the arrival of the main body of the deploying force all equipment less tracked vehicles is moved to the staging area. Battalion commanders, in coordination with this headquarters, obtain necessary route clearances from their area Transportation Movement Office (BTMO) and control the movement of equipment into the dispersal staging area.

b. Tracked vehicles are normally moved by railway transportation from the prepositioned equipment site directly to the field training exercise area. Rail movement of tracked vehicles is coordinated by this headquarters so as to arrive in the FTX area simultaneously with the arrival of the main body. All rail transportation is requested by this headquarters.

RECEPTION OF DEPLOYING FORCES

Reception of the deploying force is accomplished by the airfield control group(s) (AGC) established at the arrival airfield(s). The airfield control group coordinates the reception of troops, necessary processing, and movement of troops to their respective dispersal staging areas. The airfield control group makes the necessary reports as outlined in the operations plan published by this headquarters.

Airfield liaison teams are provided by this headquarters to maintain close liaison with the airfield control group. Normally the liaison team is composed of two (2) officers, two (2) non-commissioned officers and two (2) radio/telephone operator drivers.

Transportation for incoming troops and cargo is provided by transportation units in coordination with the airfield control group. Troops are moved from the arrival airfield to their respective dispersal staging area by army bus whenever possible. Cargo trucks usually accompany the troop buses so that each individual's luggage is available as soon as he arrives in the staging area. Cargo (other than troop luggage) is moved to the staging area unless otherwise specified by the deploying force commander.

ACTIVITIES AFTER ARRIVAL OF DEPLOYING FORCE

This headquarters arranges that continuous support is available to the deploying forces. Assistance in every aspect, logistical, administrative, technical and/or operational, will be provided as requested by the deploying force.

Deploying forces are attached to this headquarters during their stay in the dispersal staging area. . . . The mission of this headquarters is to help and assist the deploying force commander in every way possible.

Deploying forces remain in the dispersal staging area for approximately four (4) days. During this period of time deploying forces should complete the required training orientations and familiarize personnel with equipment. Deploying forces are moved from the staging area(s) to their designated training area via motor convoy. Movement orders and route clearances are published by this headquarters. Upon departure from the staging area, the deploying forces come under the operational control of their respective corps.

SUPPLY OF PREPOSITIONED EQUIPMENT AND ASSOCIATED SUPPLIES

a. Stockage Objectives. All TOE equipment and prescribed loads, with exception of ordnance small arms, aircraft and ammunition, will be prepositioned and stored by battalions of this Group. Excepted items will be prepositioned and stored in Seventh Army and COMZ Depots (See paragraph 1b (2) below).

b. Procurement:

(1) Initial Issue: Initial issue and delivery of prepositioned TOE equipment and associated supplies is effected by supply control agencies of COMZ and Seventh Army. Property book officers will submit requisitions found short in initial issue items to the

appropriate direct support unit. Components found short in initial issue major items will be requisitioned by the unit receiving the major item.

(2) Equipment Prepositioned in Depots.

(a) Requisitions for small arms will be prepared, omitting the document number and the signature block, and placed in a suspense file. Upon notification that weapons will be issued, suspense copies will be completed, entered in the document register, and processed. Small arms are prepositioned in the general depot adjacent to unit locations.

(b) Aircraft do not require requisitions. This equipment will be issued with documentation.

(c) Ammunition. Requisitions for small arms ammunition will be prepared omitting the document number and signature block, and placed in a suspense file. Upon notification that ammunition will be issued, suspense copies will be completed, entered in document register, and processed.

(d) POL: Basic load of POL for the prepositioned Infantry Division, Armored Division and attached units is stored in Seventh Army Supply Points. Prepositioned vehicles will be stored with fuel tanks full.

(3) Cryptographic Equipment: Cryptographic equipment is stored by this headquarters, and will be issued only to the unit cryptographic custodians of deploying units. Upon issue, paragraph 10, Seventh Army Regulation 735-30 will apply.

(4) ASL & AOSL: Prepositioned ASL and AOSL stockage lists will be established and maintained in accordance with Seventh Army Regulation 735-2. Working AOSL's will be utilized for normal maintenance. All ASL's and AOSL's will be continually reviewed and revised to keep them in an up-to-date status.

(5) Replacement Issues: Items required as replacements will be requisitioned by the property book officers from the appropriate direct support unit.

(6) Lateral Transfers will be submitted to the S4 this hqs for approval.

(7) Military publications will be prepositioned in accordance with regulation 310-5, this headquarters, dated 1 April 1964.

UTILIZATION OF PREPOSITIONED EQUIPMENT

VEHICLES: A limited number of prepositioned vehicles may be removed from storage and utilized for administrative purposes. Vehicles may be rotated from storage. Complete "S" services will be made and preservation applied prior to placing vehicles back into storage. Vehicles will be utilized for administrative purposes in accordance with Letter, this headquarters, subject: Utilization of Prepositioned Equipment, dated 1 April 1964.

TOOL SETS AND RELATED EQUIPMENT: This equipment may be used as required for the maintenance of prepositioned equipment. Only those items actually utilized for this purpose will be removed from depot pack. When equipment is no longer required it will be cleaned, preserved, repacked and returned to storage.

STORAGE AND MAINTENANCE

In-Storage Segregation. Equipment will be stored by TOE company and battery and within these units by technical services. Where space permits, further segregation by platoon and section is desirable. Warehouses will be organized to facilitate outloading of equipment in accordance with unit loading plans. Each warehouse will have at the entrance a diagram showing the arrangement of its construction. Depot packs containing quantities greater than the allowance for one company will be stored separately within warehouses. Sensitive items such as binoculars will be appropriately secured.

Except as modified in this Appendix, all equipment will be stored in depot pack configuration. Five percent (5%) of depot packed equipment will be inspected each calendar quarter for evidence of in-storage deterioration. Whenever deterioration is detected, all like equipment will be opened, serviced as required and returned to depot pack.

Maintenance of prepositioned equipment will be as directed herein, and in compliance with Cir 735-2, this headquarters, 1 April 1964.

Standards. Maintenance standards are as outlined in Seventh Army Regulations 750-7 and 750-5.

STORAGE OF PREPOSITIONED CHEMICAL EQUIPMENT

TOE Protective Masks will not be prepositioned. This equipment will accompany troops arriving to pick up prepositioned equipment.

Chemical ammunition for prepositioned units has been prepositioned at Seventh Army Depots.

STORAGE OF PREPOSITIONED ENGINEER EQUIPMENT

Heavy construction equipment will be stored in open storage (hardstand where available).

Small generators, air compressors, pumps, etc., will be stored in covered storage, and will be centralized in each battalion.

Precision instruments, topographic equipment, and other sensitive type items will be stored in covered storage which can be secured against pilferage.

Oxygen and acetylene will be stored separately in dry, well-ventilated storage sheds, fifty (50) feet from an occupied building. Storage buildings will be twenty (20) feet apart.

Bridging, generators, compressors, and battery chargers which are normally combat loaded aboard trailers will be mounted and maintained in this position.

Engineer material and equipment processed for long-term storage that has component parts will be packaged with component.

All mechanical and non-mechanical equipment received in level A depot pack will be retained in this condition. All equipment received in depot pack less than level A will be opened and processed for preservation.

Engineer mechanical equipment being received not in depot pack, will be technically inspected and required maintenance performed prior to issue by the supporting Engineer Field Maintenance Unit.

Engineer equipment, i.e., battery chargers, required for maintenance of prepositioned equipment may be deprocessed and placed in operational condition.

All engineer mechanical equipment being placed in preserved status will receive an "S" Service prior to application of preservation.

Pneumatic tires standing in storage will be inflated to the proper pressure.

When equipment has received application of preservation, preventive maintenance and inspection will be performed as follows:

(1) All equipment in preserved status will be inspected for any unusual conditions such as damage, rusting, accumulation of water, pilferage, and leakage of lubricants, fuels, or coolant once a month. DA Form 5-74 (Condition of engineer equipment during storage unit record) will be utilized to record these inspections.

(2) DA Form 2404 (Equipment inspection and maintenance worksheet) will be executed on each major item of equipment or each group of minor items of equipment when equipment is initially placed into preserved status, and every 180 days thereafter. Required maintenance will be performed promptly to insure that equipment is mechanically sound and ready for immediate use.

(3) Exercising: All engineer mechanical equipment will be operated long enough to bring it up to its operating temperature and for complete lubrication of all bearings, gears, etc. At least once every 180 days, equipment must be serviced and restored to satisfactory operating condition. Before, during, or after operation deficiencies will be corrected in accordance with current maintenance policies. The "before, during and after operation" checks in appropriate technical manuals and technical bulletins will be adhered to.

A five percent (5%) spot surveillance inspection will be conducted at least once each three (3) months, for all stored engineer equipment and materials. Where deterioration is found, all like equipment or material will be opened and serviced as required.

STORAGE AND SUPPLY PROCEDURES FOR MEDICAL EQUIPMENT

Medical sets, kits and outfits will be unpacked upon receipt, inventoried for completeness and serviceability.

Surgical and dental instruments may be retained in the original depot pack if no operational need is indicated. Unpacked instruments on hand which are not required for operational purposes will be processed for long-term storage in accordance with Circular 735-2, this headquarters.

Items coded "F" (Subject to damage from freezing) in the Federal Supply Catalog for Medical Materials will be stored in heated areas. When heated storage space restrictions prevent storing the entire set, the freezable components will be removed from the sets and stored in a heated area.

Surveillance and Serviceability Inspections: Surveillance and Serviceability inspections will be performed once every three (3) months on all medical sets, kits and outfits coded "C" in the Federal Supply Catalog. These inspections may be performed more frequently when recommended by the Medical Supply Officer.

Narcotics, Alcoholic Beverages and Medical Security Items: Narcotics, alcoholic beverages and items of medical security which are to be destroyed or suspended from further use will not be destroyed at the unit level, but will be turned in to the Medical Supply Officer for disposition.

STORAGE OF PREPOSITIONED ORDNANCE EQUIPMENT

Vehicles: Vehicles will be placed in administrative storage after completion of "S" Service. A completed information card will be attached to the lower right hand corner of the windshield to signify completion of the "S" Service. The front of the card, as viewed through the windshield from outside, will show maintenance battalion and TD company designation and date vehicle was placed in storage. Date will be shown by numbers in three groups: day-month-year. Figures and letters will be one inch high, and applied with a black grease pencil. The card will be taped to the windshield of wheeled vehicles; to the left front side of the hull under the headlight of tanks and recovery vehicles; and to the right front side of the hull below the commanders hatch on Armored Personnel Carriers. Those vehicles on which preservation has been completed will have a one half inch red tape line running from the lower left corner diagonally across to the upper right hand corner of the administrative storage card.

Wheeled vehicle OEM will be stored in warehouses. Tank OEM, less gun shield covers, bore evacuator blast deflector, and tarps, will remain in storage. Packaged APC OEM may be stored in vehicles.

Vehicle maintenance operations will be centralized by each battalion of this group with the exception of those detachments at separate Kasernes. Battalion commanders are responsible for the planning, organization and supervision of the centralized maintenance operation.

Vehicles evacuated to the supporting ordnance units will be free of first and second echelon deficiencies.

First echelon maintenance will be performed as follows:

First echelon teams will be formed and assigned a definite number of vehicles. Each team will be responsible for the performance of driver maintenance.

A qualified individual will supervise the activities of the first echelon team. This individual will be prepared to conduct on-the-job training of personnel on proper maintenance procedures.

Second echelon maintenance operations will be centralized by each battalion of this group under the supervision of a designated maintenance officer. Second echelon maintenance operations will be conducted as indicated below:

"S" type maintenance services will be prepared on all vehicles, striving to attain a goal of at least one service per vehicle during each six month period.

Vehicles will receive initial and final type inspections by qualified vehicle inspectors. Inspection teams will perform this function on a full-time basis.

Maintenance personnel will be assigned to each maintenance shop on a permanent basis. The maintenance officer is responsible for forming 2d echelon teams of mechanics to perform the required services. Each team will be headed by a team chief who will be responsible for the quality of maintenance performed by his team. Size of team will vary according to the type of vehicle for which the team has primary responsibility.

Vehicle log books and preventive maintenance rosters for all vehicles assigned to a central shop will be maintained under the supervision of the shop officer. Log books and PM rosters will be physically located in the shop office and a minimum number of shop clerks will be utilized to perform required administration.

Working AOSL's will be consolidated at the highest level commensurate with the efficiency of the operation.

Battalion commanders will ensure that centralized shops are equipped with the authorized 2d echelon tool sets, special tools, general mechanic tool sets, grease, oil, paint, etc., to perform "S" type services as expeditiously as possible.

Vehicles awaiting parts will be returned to the motor park and appropriately tagged.

Personnel will be instructed on and required to perform maintenance services in the sequence listed in the pertinent technical manuals. The Group S4 has published check lists for each type of vehicle assigned to the Group. These check lists will be used by each mechanic, will be filled out for each "S" service performed on each vehicle, with each step being initialed as completed by the mechanic.

Each unit will maintain a record of MWO's pertinent to each item of ordnance equipment. This record will show those MWO's that are applicable but have not been applied, and will be recapped by type equipment. Applied MWO's will be recorded on DA Form 2408-5. Modifications listed in DA Pamphlet 310-4 and those directed by Seventh Army Ordnance Maintenance Letters will be included. Paragraph 44, section II, chapter 4, TM 38-750 will be complied with in recording MWO's.

STORAGE OF PREPOSITIONED QUARTERMASTER EQUIPMENT

Quartermaster equipment will be stored in covered storage.

Equipment received in level "A" depot pack may be retained in depot pack. Equipment received in less than level "A" depot pack will be removed from depot pack, maintained in accordance with the applicable TM and preservation applied.

Class I basic load will be stored at unit level and will be stored in such a manner as to permit free air circulation around each container.

Tentage will be so stored as to permit maximum air circulation. Two (2) high and when so stacked, will be separated by dunnage. A manila tag, showing stock number, nomenclature, and date of last inspection, will be attached to the tent or burlap cover.

Vehicles will be placed in administrative storage with full fuel tanks.

Basic load not stored in vehicle fuel tanks will be stored in Seventh Army depots, or on organic POL vehicles authorized by the Supply and Transport Battalion and separate units.

MAINTENANCE OF PREPOSITIONED SIGNAL EQUIPMENT

Radio equipment will remain installed in track vehicles; accessories will be removed from track vehicles and stored in covered storage.

Radio sets (less mounts) to include control boxes and accessories, will be removed from wheeled vehicles and stored in a centralized location designated by each battalion commander. If placed in preservative envelopes they may be stored with the battalion of prepositioned TOE equipment to which they belong.

Portable radio sets, such as the AN/PRC-6, AN/PRC-10, etc., will be retained within detachment storage facilities.

STORAGE OF PREPOSITIONED TRANSPORTATION MATERIAL

Aircraft: Aircraft are assigned to Seventh Army and will be issued on an "on call" basis.

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